Conseil Permanent International pour
l'Exploration de la Mer
CHARLOTTENLUND SLOT — DANEMARK

46057

LIBRARY
JUL 2 1965
FISH & WILDLIFE SERVICE

RAPPORTS ET PROCÈS-VERBAUX DES RÉUNIONS

Volume 151

International Fisheries Convention of 1946

Committee on Mesh Difficulties

Report of the Scientific Sub-Committee, presented at the Seventh Meeting of the Permanent Commission, November 1958

LIBRARY
NATIONAL MARINE FISHERIES SERVICE
HONOLULU LABORATORY
P. O. BOX 3830
HONOLULU, HAWAII 96812

En Commission chez
ANDR. FRED. HØST & FILS
COPENHAGUE

Prix: Kr. 12.00

Novembre 1960

Conseil Permanent International pour l'Exploration de la Mer
CHARLOTTENLUND SLOT — DANEMARK

RAPPORTS
ET
PROCÈS-VERBAUX DES RÉUNIONS

Volume 151

International Fisheries Convention of 1946

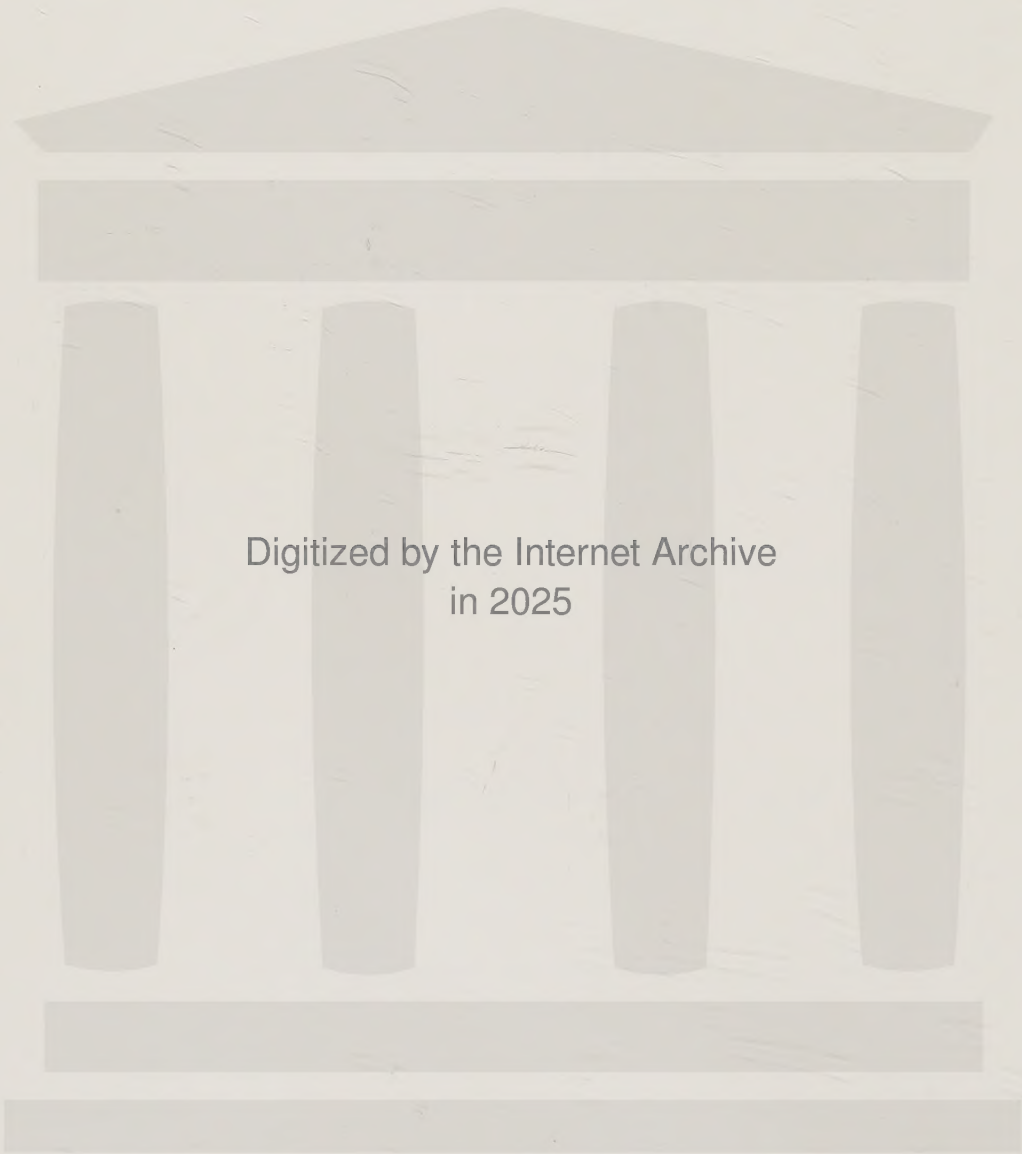
Committee on Mesh Difficulties

Report of the Scientific Sub-Committee, presented at the Seventh Meeting of the Permanent Commission, November 1958

En Commission chez
ANDR. FRED. HØST & FILS
COPENHAGUE

Prix: Kr. 12.00

Novembre 1960



Digitized by the Internet Archive
in 2025

IMPRIMERIE BIANCO LUNO A/S
COPENHAGUE

https://archive.org/details/ices-marine-science-symposia_1960-11_151

PREFACE

At the Sixth Meeting of the Permanent Commission held in London in October 1957, a Committee was set up under the chairmanship of Dr. G. J. Lienesch of the Netherlands to consider what were the precise difficulties of Member Countries as regards the application of the present mesh provisions of the 1946 Convention, and what might be done to meet those difficulties consistent with the purposes of the Convention.

At the first meeting of the Committee in London in January 1958, it became clear that insufficient information was available to the Committee to assess the various problems involved and the suggestions made in the course of the meeting for resolving them. Accordingly, a questionnaire was prepared seeking on a confidential basis full and detailed information about the whiting and the sole fisheries, and the other fisheries that might be affected by any change in the conservation regulations relating to them, and about mixed fisheries, both industrial and non-industrial, practiced by the nationals of each country concerned. A Sub-Committee of Scientists, representative of the member countries of the main Committee, was set up to consider the information received in response to this questionnaire. This Sub-Committee met immediately before the second meeting of the main Committee in The Hague in July 1958, and again before the third meeting in Copenhagen in October 1958; it submitted its Report to the full Committee which later presented it to the Commission at its Seventh Meeting.

This report is in two parts. Part I, the edited version of which is reproduced here, deals with Mixed Fisheries, that is, fisheries in which trawls with meshes smaller than those specified by the 1946 Convention are used for the purpose of capturing unprotected species listed in Article 6 of the Convention, but in which varying quantities of protected species listed in Annex II of the Convention may also be caught. The statistics for these fisheries up to the end of 1957 are presented, together with an assessment, so far as is possible on the data available, of the significance of the by-catch of protected species in relation to the fisheries for those species prosecuted in the same area with Convention mesh sizes.

The editing of Part II of the report has not yet been completed. It deals with the effects of mesh regulation in certain of the Convention fisheries, notably those of sole and whiting in which difficulties have been experienced in applying the present mesh provisions of the 1946 Convention. The data and assessments presented here related to the fisheries of specific countries and areas, and may be regarded as a logical development of the more general treatment of questions of mesh regulation contained in the *Ad Hoc* Report of 1955.

Thus Mr. Rollefsen's opinion, as expressed in his Introduction to the Report of the *Ad Hoc* Committee of 1955 that the results of that committee most certainly would serve as leading principles for future work in fishery regulation, has come true. We are all of us in debt to those scientists who have worked so hard to contribute to the solution of the North Sea fishery problems.

As was the case with the *Ad Hoc* Report 1955, a number of scientists have taken part in the preparation of this report but I do not think I exaggerate if I say that Ray Beverton and Luit Boerema have carried the heaviest burden of the work. Our thanks are due to them and their co-workers for the excellent job they have done.

Gothenburg, February 1960. *Jöran Hult.*

Table of Contents

	Page
Preface, by *Jöran Hult*	3
A. Introduction	5
B. Adult Herring and Mackerel Fisheries	6
C. Young Herring Fisheries	27
D. Sand-Eel Fisheries	33
E. Sprat Fisheries (Trawl)	34
F. Shrimp Fisheries	35
G. *Nephrops* Fisheries	36
H. *Pandalus* Fisheries	36
J. Summary of Conclusions Concerning By-Catch in Mixed Fisheries	37

PART I
MIXED FISHERIES

A. Introduction

A. 1.

Part I of this report is concerned with fisheries using small-meshed trawls, wholly or partly for the capture of species mentioned in Article 6 of the 1946 Convention. These gears are also potentially or actually capable of catching Annex II species and other "non-Article 6" species, either deliberately or as an unavoidable by-catch.

A. 2.

The gears concerned include bottom and pelagic herring trawls, Vinge trawl, sand-eel trawl, shrimp trawl and bottom and pelagic sprat trawls.

A. 3.

The species supporting what are generally termed "mixed fisheries" can be grouped into two categories:

(a) Those specifically mentioned in Article 6 and for which there are well-established fisheries; these include adult herring, mackerel, young (immature) herring, sprat, sand-eel, shrimp, and *Nephrops*.

(b) Those listed neither in Article 6 nor in Annex II; at the time this Report was prepared (October 1958) none of these were yet of major importance but mention has been made in contributions of fisheries starting on them. These species include: *Gadus esmarkii, Gadus poutassou, Onos cimbrius, Trigla gurnardus,* and *Argentina silus.*

Information is available on all species of category (a), but not much is known of category (b) fisheries. For this reason, and also because they are so far of only minor importance, category (b) species are not considered in further detail in this report.

A. 4.

A general picture of the magnitude of the Article 6 fisheries of each country, and of their importance relative to the total demersal catch by the country in question, is given in Table A.1. Countries are listed in order of magnitude of their adult herring landings, and the same order is maintained throughout. This table refers to all fisheries of this kind in the North Sea (Region IV) Skagerak and Kattegat (Region

Table A.1
Magnitude (tons) of landings from Article 6 Fisheries in Regions IIIa, IV, and VIId (average 1954–57), together with total demersal landings from Regions IIIa and IV (average 1954–56)

Country	Adult herring	Mackerel	Young herring	Sprat	Sand-eel***	Shrimp	*Nephrops*	Total demersal
Germany	183,000	4,800	29,000	3,700	26,000	36,000	70	40,000
Sweden	73,000	5,000	—*	8,400	—	—	650	40,000
Netherlands	49,000	13,000	990	1,300	3,700	16,000	—	45,000
France	47,000	19,000	—	50	—	240	60	49,000
Poland	41,000	1,700	150	60	—	—	—	1,400
Belgium	7,500	130	—	1,300	—	2,300	—	22,000
Norway	5,100	—	No data	—	3,200	—	70	42,000
Denmark	—	5,000	144,000**	22,700	79,000	—	1,000	96,000
England	—	—	—	—	—	1,600	30	76,000
Scotland	—	—	—	—	—	—	850	130,000
Total	405,600	48,630	174,000	37,500	112,000	56,000	2,900	542,000
Proportion of total emersal	0·75	0·09	0·32	0·07	0·21	0·10	0·005	

* Approximately 3–5 % of the 73,000 tons of herring caught by Sweden are young herring.
** Includes a small proportion of adult herring.
*** Data for sand-eel refer to 1957 only.

Table A.2
Value ('000 shs.) of Article 6 Fisheries corresponding to Table A.1

Country	Adult herring	Mackerel	Young herring	Sprat	Sand-eel***	Shrimps	*Nephrops*	Total demersal
Germany	108,000	1,800	7,700	2,400	4,800	12,000	500	23,000
Sweden	52,000	5,500	No data*	9,400	—	—	930	31,000
Netherlands	27,000	5,000	270	900	700	13,000	—	58,000
France	43,000	30,000	—	No data	—	1,300	220	No data
Poland	No data	No data	No data	No data	—	—	—	No data
Belgium	4,300	120	—	900	—	7,500	—	27,000
Norway	1,500	7,300	No data	—	640	—	100	19,000
Denmark	—	1,500	42,000**	6,800	16,000	—	No data	95,000
England	—	—	—	—	—	2,800	—	73,000
Scotland	—	—	—	—	—	—	2,000	120,000
Total	236 000	51,000	50,000	21,000	22,000	37,000	3,750	445,000
Proportion of total demersal	0·53	0·12	0·11	0·06	0·05	0·08	0·01	

* Approximately 3–5 % of the 73,000 tons of herring caught by Sweden are young herring.
** Includes a small proportion of adult herring.
*** Data for sand-eel refer to 1957 only.

IIIA), and the English Channel (eastern end, Region VIID), and gives average figures for the period 1954—57 as far as possible (except for sand-eel, for which 1957 figures are used). Notes on the sources of information used to compile this table will be found in later sections, which deal with each fishery and its by-catch in detail.

For comparison, Table A. 2 shows the same thing in terms of value instead of quantity, so far as information is available.

B. Adult Herring and Mackerel Fisheries

B. 1.

Adult herring and mackerel are treated under the same heading in this Report, because in most countries the two are either caught together in the same fishery or else cannot be separated from the statistics available.

B. 2.

Two main kinds of trawl are used, a bottom trawl and a floating or pelagic trawl. Much the greater part of the total catch is taken by the bottom trawl (in the region of 90 %), but no precise breakdown is possible (see, however, para. B.4 below). A number

Table B.1
Statistics of adult herring (trawl) fisheries

Country	Area	Tons	%	Price per kilo	Price (sh/kilo)	Value ('000 shs.)	%	Origin of data
Germany	North Sea	183,000	45	0·35 DM	0·59	108,000	46	Contr. av. '54–'57
	Skagerak & Kattegat	140	+	0·35 DM	0·59	80	+	Contr. av. '54–'57
Sweden	North Sea	41,000	10	0·7 sh	0·70	29,000	12	Contr. av. '54–'56
	Skagerak & Kattegat	32,000	8	0·7 sh	0·70	22,000	10	Contr. av. '54–'56
Netherlands	North Sea	49,000	18	0·3 HFl	0·58	27,000	10	Contr. av. '54–'57 and Dutch stats.
France	North Sea	47,000	12	53 FFr	0·92	43,000	19	Contr. av. '54–'57
Poland	North Sea	41,000	10	No data	No data	No data		Contr. av. '54–'57
Belgium	North Sea	7,500	2	4·0 BFr	0·57	4,300	2	Contr. av. '54–'57
Norway	North Sea	3,400	1	0·3 kr	0·30	1,000	+	Contr. av. '54–'57
	Skagerak & Kattegat	1,700	+	0·3 kr	0·30	500	+	Contr. av. '54–'57
Total		405,700	100			234,900	100	

Notes:
(i) "North Sea" includes the eastern end of the English Channel where appropriate.
(ii) The figure of 47,000 tons for France is from all areas by trawl, the North Sea not being distinguished in her contribution. As guide it can be taken that about 80 % of this is from the North Sea and Channel.
(iii) The figure of 41,000 tons for Poland is of all Article 6 species together. In 1957 it is recorded that only 5 % consisted of fish other than adult herring.
(iv) The statistics for Sweden refer to "herring"; it is assumed to be all adult herring.
(v) There has been a steep decline in the Belgian landings of adult herring over the period in question (to about 1/4).
(vi) The Norwegian landings from the North Sea show a sharp increase over the period in question (of about 3 times).
(vii) In the absence of information to the contrary, it is assumed that Denmark does not land any significant quantity of trawled adult herring.

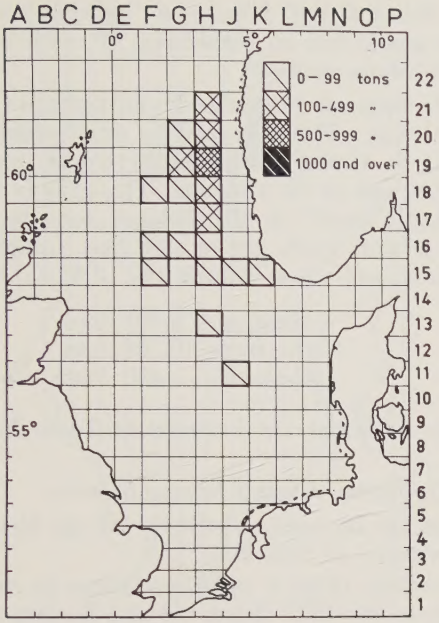


Figure 1 (a).

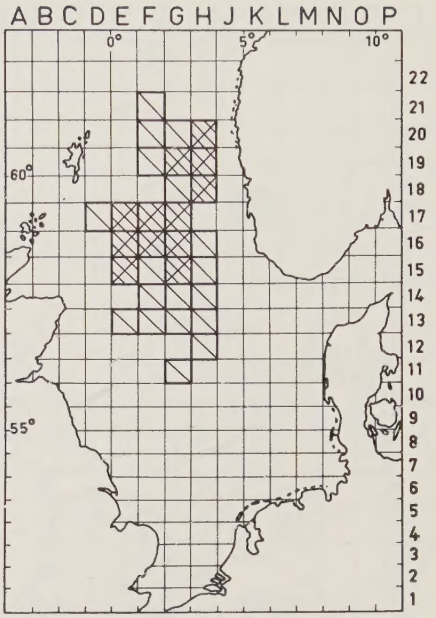


Figure 1 (b).

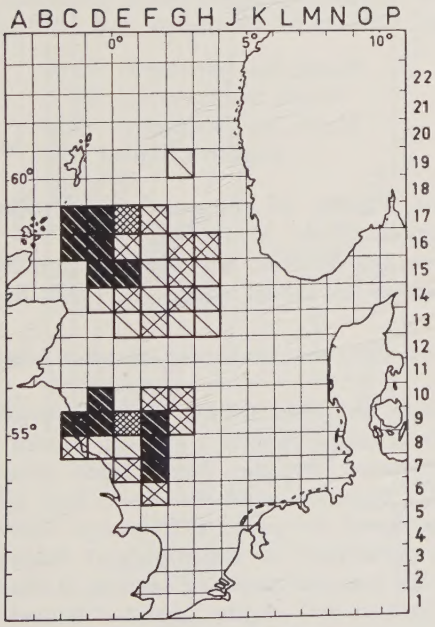


Figure 1 (c).

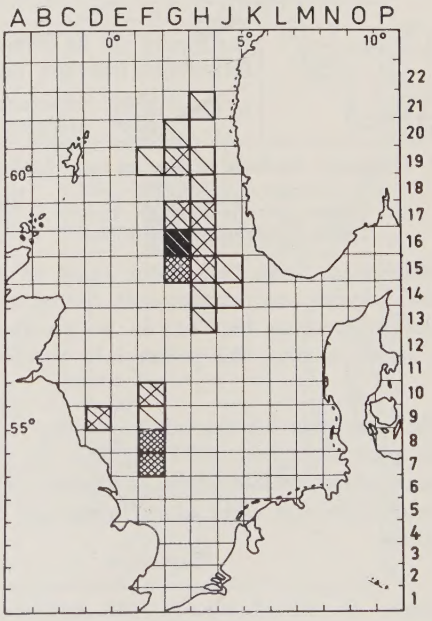


Figure 1 (d).

Figures 1 (a—d). Netherlands; landings of herring by herring trawlers in 1957, for each quarter of the year.

Figure 2. Germany; landings of herring from fishing grounds, average of years 1954—57.
Upper figure (roman) = trawlers.
Lower figure (italic) = drifters.

of variations of these two main types of gear are used and changes are continuously being introduced, but broadly speaking fisheries in which the bottom trawl is used produce the greatest by-catch.

B. 3.

Detailed statistics for the adult herring fisheries by all trawl gears are given in Table B.1. In these and subsequent tables (unless otherwise stated) prices refer to the year 1956 and rates of exchange are based on 1955 values.

B. 4.

Although, as stated above, the bottom herring trawl is by far the commonest type in use, some fishing for adult herring is carried out by pelagic trawl, the available information being as follows:—

(a) Sweden and France use pelagic as well as bottom trawls, but no breakdown of catch is possible from the data available.

(b) In Belgium, Netherlands and perhaps Germany, a special type of trawl is used by small vessels fishing in pairs, in winter, in the southernmost part of the North Sea and in the Channel. This gear is described as "pelagic trawl" in the Belgian contribution but not all pelagic trawls are of this type. Catches made by "pair trawl" are as follows (av. 1954—57):—

Belgium	6,301 tons
Netherlands	10,306 tons
(Germany	430 tons)

These quantities are included in Table B.1.

B. 5. Distribution of adult herring fisheries

Charts can be constructed only for the Netherlands and Germany, as follows:—

Netherlands (Figs. 1 (a—d)). Catches by rectangles, by quarters, for 1957. Sandettié and Eastern Channel excluded.

Germany (Fig. 2). Quantities caught by main fishing grounds (av. 1954—57). Information for other countries can be summarized as follows:—

Belgium. Fishery starts on the Fladen Ground in July; works south and west to west end of Dogger Bank in October; finishes in winter in southern part of the North Sea and eastern end of Channel.

Poland. Catches by sub-regions (av. 1955—57):—

North Sea (northern)	43 %
North Sea (central)	48 %
North Sea (southern)	5 %
English Channel	5 %

France. Fishing all the year round, covering all three regions of the North Sea.

Norway and Sweden. Divided only into North Sea and Skagerak, as shown already in Table B. 1.

B. 6. Comments on distribution of adult herring fisheries

For those countries fishing over the whole of the North Sea, fishing follows a general pattern which is best illustrated by the Netherlands charts (Fig. 1 (a—d), together with the note that all of the countries listed in para. B. 5 except Norway and Sweden participate in an important fishery at the close of the year on spawning herring at the entrance to and eastern end of the English Channel.

In general, the main catches come from the Fladen in the summer months, and West Dogger in early autumn.

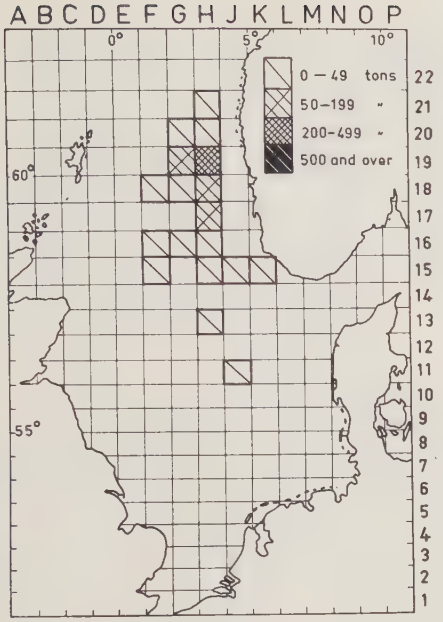


Figure 3 (a).

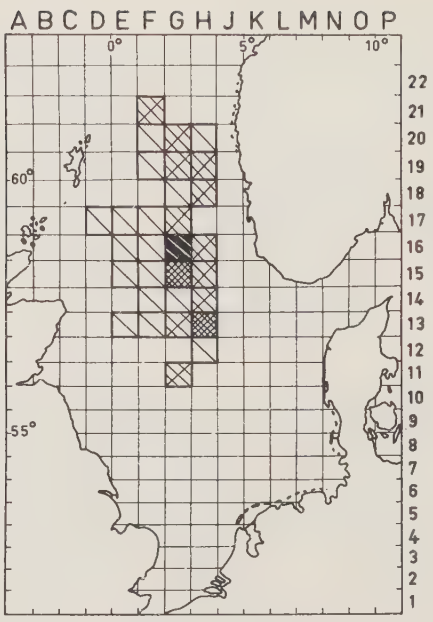


Figure 3 (b).

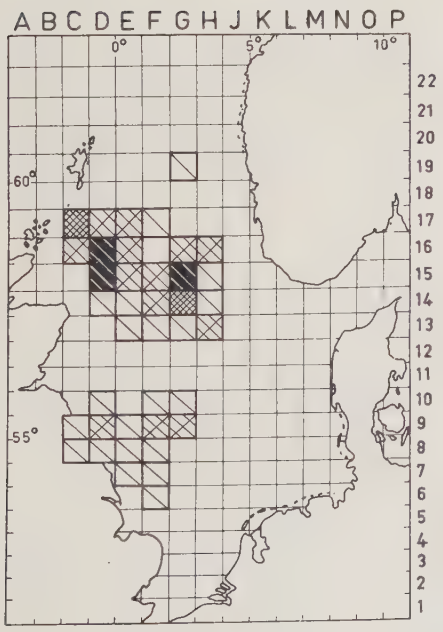


Figure 3 (c).

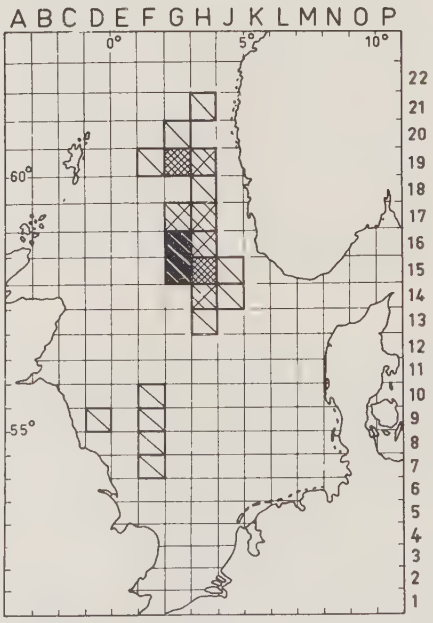


Figure 3 (d).

Figures 3 (a—d). Netherlands; landings of mackerel by herring trawlers at IJmuiden in 1957, for each quarter of the year.

Table B.2
Landings of mackerel by herring trawl

Country	Area	Tons	%	Price per kilo	Price (sh/kilo)	Value ('000 shs)	%	Origin of data
Germany	North Sea	4,800	10·0	0·22 DM (1957)	0·37	1,800	4·1	Bull. Stat. '54–'56
	North Sea	750	1·6	1·1 sh	1·1	800	1·8	Bull. Stat. '54–'56
Sweden	Skagerak & Kattegat	4,450	9·3	1·1 sh	1·1	4,850	11·1	Bull. Stat. '54–'56
Netherlands	North Sea	13,000	27·1	0·2 Hfl	0·38	5,000	11·4	Bull. Stat. '54–'56
France	North Sea	19,000	39·6	95 FFr	1·9	30,000	68·4	Bull. Stat. '54–'56
Poland	North Sea	1,700	3·5	No data	No data	No data	—	Bull. Stat. '55–'56 Contr. '57
Belgium	North Sea	130	0·3	6·3 BFr	0·9	120	0·3	Contr. '54–'57
Denmark	North Sea	900	1·9	0·3 sh	0·3	270	0·6	Bull. Stat. '54–'56
	Skagerak & Kattegat	3,200	6·7	0·3 sh	0·3	1,000	2·3	Bull. Stat. '54–'56 Contr. '57
Total		47,930	100			43,840	100	

Notes

(i) Quantities for Poland and Netherlands include a very minor quantity caught by drift-net (Bull. Stat., Table 7).

(ii) Part of the catch of a number of countries may have been taken by large-meshed trawls (*i.e.* 75 mm). No general breakdown of the total catches in this respect is possible, but it is believed that the greater part have been taken by small-meshed trawls. It can, however, be stated that the whole of the Belgian catch, probably the whole of the Polish, and over 80 % of the German and Netherland catches, were taken with small-meshed trawls.

(iii) As in the case of adult herring, the bottom trawl is the type mainly used. In the case of Netherlands, Belgium and Germany the proportion of mackerel caught by pelagic trawl compared with bottom trawl is even smaller than is the proportion of herring.

B. 7. Mackerel landings

Before coming to the by-catch in the adult herring fisheries it is necessary to present the statistics for *mackerel,* which is caught in the same or similar fisheries. Table B. 2 shows the data for mackerel caught by trawl.

B. 8. Distribution of mackerel fisheries

All the information available on mackerel comes from combined adult herring and mackerel fisheries, and so the distribution of the mackerel fisheries is broadly similar to that already described in para. B. 5. Charts are available for Netherlands only (Figs. 3 (a–d)), from which it will be seen that there are, however, some differences in the centres of distribution of the two species. There is no information on the existence of any major trawl fisheries exclusively for mackerel, although in some months and areas the landings of Dutch trawlers may consist nearly wholly of mackerel.

B. 9. "By-catch" in adult herring/mackerel fisheries—general remarks

(a) Information on the "by-catch" taken in these fisheries has been supplied by most of the countries concerned, in varying degrees of detail. Because the quantity and composition of the by-catch may be critically dependent on whether a bottom or pelagic trawl is used, as well as on the location of the fishery in question, the type of trawl is usually specified in the information on by-catch, and is distinguished in what follows. In so doing, it is recognized that even quite small variations in the rig or design of either type of trawl may have a big influence on the by-catch, but information relating to details of this kind is as yet unavailable for commercial fisheries. Data with respect to bottom trawls are given in Table 3 and following tables.

(b) The main Annex II species comprising the by-catch in the adult herring/mackerel fisheries are cod, haddock and whiting. In addition, large quantities of coalfish (particularly in Germany) and smaller quantities of other "non-Annex II" species are landed, but these are not reported separately.

(c) In many instances a substantial part of the by-catch is discarded at sea; it is therefore important in what follows to bear in mind the distinction between the quantity actually caught (the "catch") and the quantity subsequently landed (the "landings").

(d) Because of differences in the composition of the by-catch, the Skagerak and Kattegat is treated separately from the North Sea and Channel in the following tables.

B. 10. Values of by-catch

Separate tables for these values are not given but some notes are as follows:—

Whiting: Price about $^1/_3$ higher than herring in Sweden; a little higher (10 % to 20 %) in Netherlands and France; a little lower in Germany and Belgium.

Cod: Between one-and-a-half and three times higher than herring in all countries.

Haddock: About the same as herring in Belgium and France, about 10 % higher in Germany, about 40 % higher in Netherlands and three times as high in Sweden.

B. 11. By-catch—monthly landings

The data of Table B. 3 can also be given by months for all countries except France, and they show some important features (Tables B. 4 and B. 5). The same notes apply as in the case of Table B. 3.

Table B.3
Landings (tons) of herring and mackerel, and by-catch, from adult herring fisheries (bottom trawl); North Sea and English Channel

Country	Herring and mackerel (tons)	By-catch (tons) Cod	Haddock	Whiting	Other non-Art. 6	All non-Art. 6 spp.	Years
Germany	172,000	2,600	1,200	600	11,000	15,400	'54–'57
Sweden	2,000	20	4	2	80	108	'54–'56
Netherlands	51,000	2,500	8,900	3,300	5,600	20,300	'54–'57
France	66,000	1,800	3,300	11,000	3,300	19,500	'54–'57
Poland	43,000	←	1,900	→	?	1,900	'57
Belgium	1,400	21	27	37	No data	86	'54–'57
Total	335,400	6,941	15,331	14,939	19,980	57,294	
	Herring and mackerel (%)	By-catch as % of total landings					
Germany	91·8	1·4	0·6	0·3	5·9	8·2	
Sweden	94·9	1·0	0·2	0·1	3·8	5·1	
Netherlands	71·5	3·5	12.5	4·6	7·9	28·5	
France	77·2	2·1	3·9	12·9	3·9	22·8	
Poland	95·8	←	4·2	→	?	4·2	
Belgium	94·2	1·4	1·8	2·5	No data	5·8	
Total	85·4	1·8	3·9	3·8	5·1	14·6	

Notes:

(i) Data for *Germany* do not include small quantities caught either by vessels homeward bound from distant waters (about 1%) or by luggers fishing with herring trawl. The latter catch about 8% of the total herring and mackerel and presumably a corresponding by-catch, although it appears that very little of this is landed. An unknown part of the recorded by-catch (but mainly coalfish) may have been taken by large-meshed trawls.

(ii) Data for *Sweden* refer to the ports of Gravarne and Smögen only; in 1957 about 5% of the total North Sea trawl-caught herring (Swedish) was landed at these two ports. The category "other non-Article 6 spp." for Sweden includes 23 tons of industrial fish, species not specified.

(iii) Area and type of gear are not distinguished for *France*; it is assumed that the catches of gadoid fish given in Table C of the French contribution were taken by herring trawl. The whiting are in fact caught by several types of trawl but the breakdown is not known. The entry of 3,300 tons under "other non-Article 6 spp." for France is entirely hake; no information is available on other species.

(iv) Data for *Poland* refer only to the by-catch of "protected" (*i.e.* Annex II) species.

(v) Figures for *Netherlands* have been arrived at by taking data for trawlers as being applicable also to luggers.

(vi) *Belgian* data of by-catch refer to cod, haddock and whiting only.

Table B.4
Statistics of adult herring fisheries (tons); Germany and Sweden (ports of Gravarne and Smögen only)

GERMANY

Month	Herring	Mackerel	Cod	Haddock	Whiting	Other non-6	Total non-6
January	1,500	210	34	33	92	1,100	1,200
February	1,300	220	45	36	130	1,400	1,600
March	1,900	310	64	100	110	2,100	2,300
April	2,700	800	26	26	91	1,400	1,600
May	1,100	340	22	39	26	1,000	1,100
June	1,200	37	85	76	27	570	760
July	18,000	680	580	220	14	570	1,400
August	41,000	1,500	590	200	21	760	1,600
September	38,000	800	490	190	10	470	1,200
October	28,000	690	540	200	11	570	1,300
November	19,000	470	65	24	34	540	660
December	12,000	69	19	45	33	580	680
Total	166,000	6,100	2,600	1,200	600	11,000	15,400

Table B.4 (continued)

SWEDEN

Month	Herring	Mackerel	Cod	Haddock	Whiting	Other non-6	Total non-6
January	—	—	—	—	—	—	—
February	—	—	—	—	—	—	—
March	7	0·2	+	0·1	0·4	0·3	0·8
April	19	3	0·4	0·2	0·4	2	3
May	3	1	0·2	0·3	0·2	2	2
June	—	—	—	—	—	—	—
July	160	2	3	0·9	0·2	13	16
August	1,100	21	10	—	—	44	54
September	560	10	5	2	0·5	8	15
October	120	0·4	0·6	0·1	0·1	2	3
November	10	0·9	0·2	0·6	0·7	10	12
December	—	—	—	—	—	—	—
Total	1,940	39	19	4	2	80	108

Table B.5
Statistics of adult herring fisheries (tons); Poland, Netherlands and Belgium

	Poland			Netherlands							Belgium						
Month	Herring	Mackerel	By-catch Gadidae	Herring	Mackerel	Cod	Haddock	By-catch Whiting	Other non-6	Total non-6	Herring	Mackerel	Cod	Haddock	Whiting	Other non-6	Cod + Haddock + Whiting
Jan.	42	24	58	230	41	130	550	270	270	1,200	—	—	—	—	—	—	—
Feb.	73	11	45	320	86	190	480	360	490	1,500	—	—	—	—	—	—	—
Mar.	430	63	140	710	330	180	470	440	780	1,900	—	—	—	—	—	—	—
Apr.	1,500	350	360	870	1,800	240	530	370	640	1,800	—	—	—	—	—	—	—
May	2,100	380	330	470	2,200	370	590	200	600	1,800	—	—	—	—	—	—	—
June	4,300	120	250	520	1,400	330	960	160	390	1,800	—	—	—	—	—	—	—
July	8,500	220	410	3,700	1,100	310	800	190	430	1,700	67	11	6	4	3	—	14
Aug.	11,000	170	130	10,000	1,500	190	860	360	240	1,600	350	55	5	8	15	No data	28
Sept.	7,800	240	110	12,000	1,400	170	830	220	150	1,400	330	22	5	6	8		19
Oct.	3,400	99	60	5,800	1,400	140	960	140	350	1,600	330	20	4	8	6		18
Nov.	2,000	23	4	2,200	880	140	1,000	210	380	1,700	62	25	0·3	0·9	4		5
Dec.	550	—	—	2,400	210	130	890	370	870	2,300	91	—	0·3	—	1·4		2
Total	41,400	1,700	1,900	38,800	12,300	2,500	8,900	3,300	5,600	20,300	1,200	130	22	27	37		86

B. 12.

To show the relative importance of the various species making up the total landings from adult herring and mackerel fisheries in the different countries, Table B. 6 gives the quantities of cod, haddock, whiting, "other non-Article 6" species, and "total non-Articles 6" species of Tables B. 4 and B. 5 as percentages of the total landings by months.

B. 13. Comments on Table B. 6

(a) The total annual landings of by-catch range from 5 % (Sweden) to 28 % (Netherlands) of the total, and rather more by value.

(b) For most countries in some months, the landings of non-Article 6 species are of the same order of magnitude as the herring and mackerel landings, or may even exceed them by a considerable margin (Netherlands). In these particular months, the Netherlands' by-catch landings are mainly of Annex II species, while those of Germany are mainly of coalfish.

(c) There is an extreme change during the year in the magnitude of by-catch landings compared with those of herring and mackerel, the by-catch proportion being lowest during the summer and autumn, when herring and mackerel catches are at their peak.

(d) On the other hand, it by no means follows that the by-catch is itself low at this time. In general, the actual magnitude of the total by-catch landings is about average, or even a little above average, when the proportion they comprise of the total landings is lowest. In some species and for some countries, (e.g., cod and haddock for Germany and haddock for Netherlands) the by-catch landings are, in fact, greatest when they are the smallest percentage of the total landings. Thus it must be concluded that percentage composition by species alone is of little help

Table B.6
Landings of by-catch as percentage of total landings

	Germany					Sweden					Poland	Netherlands					Belgium			
Month	Cod	Had-dock	Whit-ing	Other non-6	Total non-6	Cod	Had-dock	Whit-ing	Other non-6	Total non-6	Gad-oids	Cod	Had-dock	Whit-ing	Other non-6	Total non-6	Cod	Had-dock	Whit-ing	Cod+Had-dock+Whit-ing
Jan....	1·2	1·1	3·2	37·8	41·3	—	—	—	—	—	46·8	8·8	37·4	18·4	18·4	81·6	—	—	—	—
Feb. ..	1·4	1·2	4·2	44·9	51·3	—	—	—	—	—	34·9	10·0	25·2	18·9	25·7	78·7	—	—	—	—
Mar...	1·4	2·2	2·4	46·6	51·0	+	1·2	5·0	3·8	10·0	22·1	6·1	16·0	15·0	26·5	64·6	—	—	—	—
April..	0·5	0·5	1·8	27·5	31·4	1·6	0·8	1·6	8·0	12·0	16·3	5·4	11·9	8·3	14·3	40·3	—	—	—	—
May ..	0·9	1·5	1·0	39·4	43·3	3·0	4·5	3·0	29·8	40·3	11·8	8·3	13·2	4·5	13·4	40·3	—	—	—	—
June ..	4·3	3·8	1·4	28·5	38·1	—	—	—	—	—	5·3	8·9	25·8	4·3	10·5	48·4	—	—	—	—
July...	2·9	1·1	0·1	2·8	7·0	1·7	0·5	0·1	7·3	9·5	4·5	4·8	12·3	2·9	6·6	26·2	6·6	4·4	3·3	15·4
Aug. ..	1·3	0·5	0·1	1·7	3·6	0·9	—	—	3·7	4·6	1·2	1·4	6·6	2·7	1·8	12·2	1·2	1·8	3·5	6·5
Sept...	1·2	0·5	0·0	1·2	3·0	0·9	0·3	0·1	1·4	2·6	1·4	1·1	5·6	1·5	1·0	9·5	1·3	1·6	2·2	5·1
Oct. ..	1·8	0·7	0·0	1·9	4·3	0·5	0·1	0·1	1·6	2·4	1·7	1·6	10·9	1·6	4·0	18·2	1·1	2·2	1·6	4·9
Nov. ..	0·3	0·1	0·2	2·7	3·3	0·9	2·7	3·1	44·6	53·6	0·2	2·9	20·9	4·4	7·9	35·6	0·3	1·0	4·3	5·4
Dec. ..	0·1	0·4	0·3	4·6	5·3	—	—	—	—	—	—	2·6	18·1	7·5	17·7	46·8	0·0	–	1·5	2·2
Total..	1·4	0·6	0·3	5·9	8·2	0·9	0·2	0·1	3·8	5·1	4·2	3·5	12·5	4·6	7·8	28·4	1·6	1·9	2·6	6·1

Notes:

(i) The above figures relate to the North Sea and Channel, although very little by-catch is taken in the latter area. For Germany figures of total non-Article 6 species for the North Sea (excluding the Channel) in the months in question (November, December and January) are 8 %, 63 %, and 71 % respectively. No breakdown of the Netherlands figures in this way is possible, but a similar effect can be expected for these three months, especially in November and December.

(ii) Figures for Poland and Belgium in November and December refer exclusively to the Channel, and in January exclusively to the North Sea. Sweden has no fishing in the Channel.

(iii) Figures for Sweden are based on landings at Gravarne and Smögen only.

when attempting to establish the true importance of the by-catch in mixed fisheries of this kind.

B. 14. Some general observations on the character of adult herring/mackerel fisheries

(a) It is evident from the preceding tables that the pattern of these fisheries differs according to the time of year. In the summer and autumn the fisheries are essentially for herring and mackerel, with other species usually being an incidental and presumably unavoidable "by-catch" in the true sense of the word. In the winter, however, it is equally clear that the "by-catch" may be a major part of the landing and that the fishery could not subsist without it.

(b) In this connexion it is stated in the *Netherlands* contribution that although herring and mackerel remain the prime objective in winter, their scarcity at this time is such that it is necessary deliberately to fish for other species until a sufficient concentration of herrings or mackerel is encountered. It would appear to be impracticable to do this except with small-meshed gear, since the vessels cannot afford to miss the opportunity of catching as much herring and mackerel as possible.

(c) The position for *Germany* is rather different, in as much as the main non-Article 6 species landed in winter is coalfish, much of which is probably caught in the northernmost North Sea with large-meshed trawls (75—120 mm). Again, however, it is stated in the German contribution that herring is the main objective in the German winter fisheries.

(d) No information on the objectives in adult herring/mackerel fisheries of other countries is given in contributions.

B. 15. Spatial distribution of by-catches

Something of the spatial distribution of by-catches can be deduced from the information already presented in paras. B. 5 and B. 6. Additional information for the Netherlands shows catches of haddock and whiting by quarters and rectangles (Fig. 4(a—d) and 5 (a—d)). It will be seen from these charts that although there are differences between the rectangles giving the greatest herring and mackerel catch and those giving the greatest by-catch, there is no clear-cut spatial separation between the two categories of fish.

B. 16. Quantities and size compositions of by-catch of Annex II species, "as caught"

Before attempting to assess the effect of the capture of Annex II species in adult herring/mackerel fisheries, it is first necessary to review the information available on the magnitude of the *catches* of these species (as opposed to landings, as treated hitherto) and their size compositions. Little information of this kind is available for cod, so only haddock and whiting can be dealt with fully in what follows.

The information available is as follows:—

Germany. Length compositions of research vessel catches of haddock and whiting taken in the various commercial fishing areas by herring trawl. A few ob-

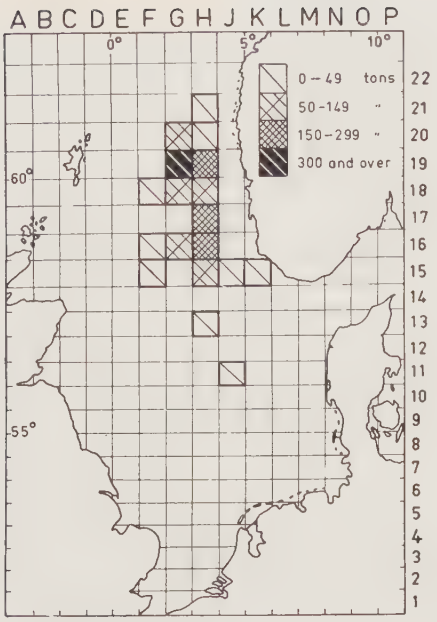


Figure 4 (a).

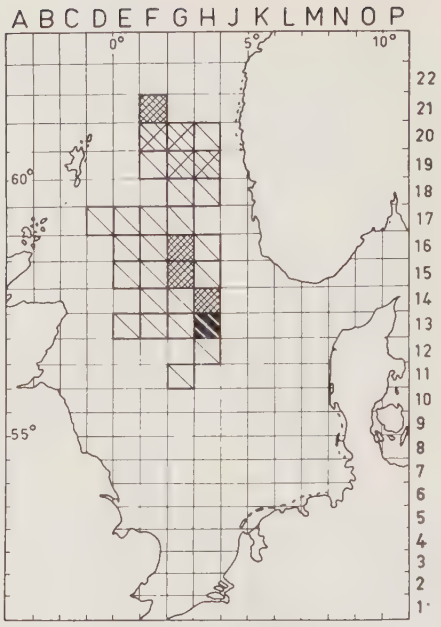


Figure 4 (b).

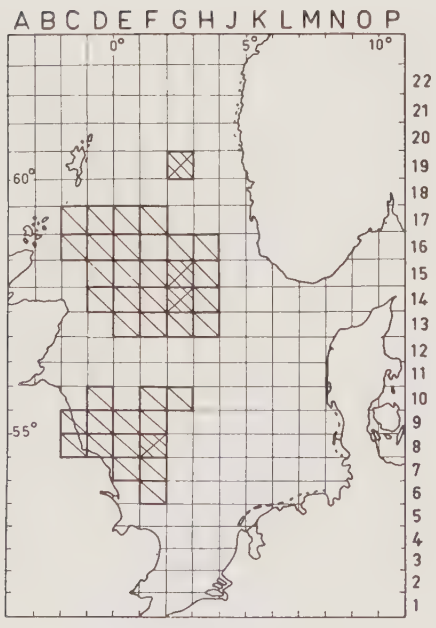


Figure 4 (c).

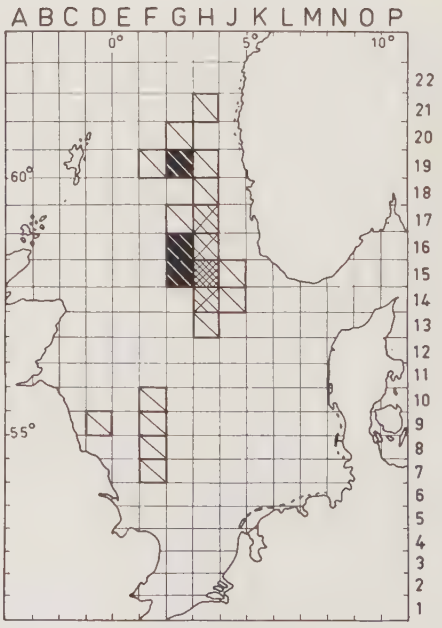


Figure 4 (d).

Figures 4 (a—d). Netherlands; landings of haddock by herring trawlers at IJmuiden in 1957, for each quarter of the year.

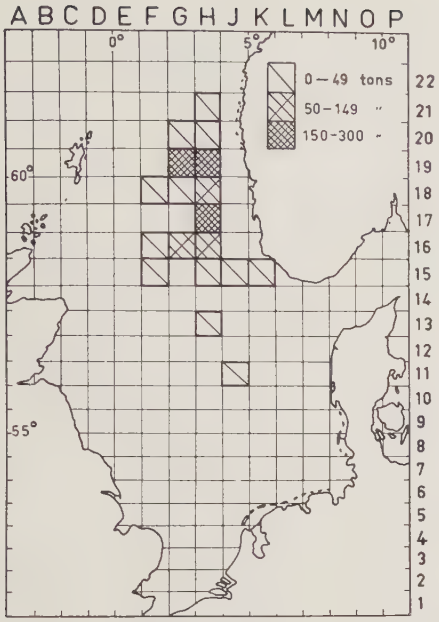


Figure 5 (a).

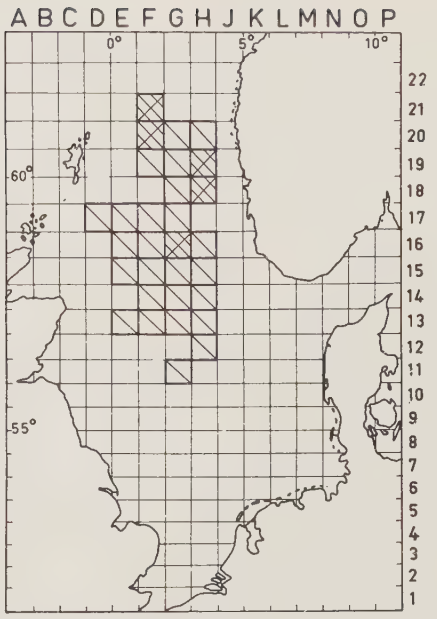


Figure 5 (b).

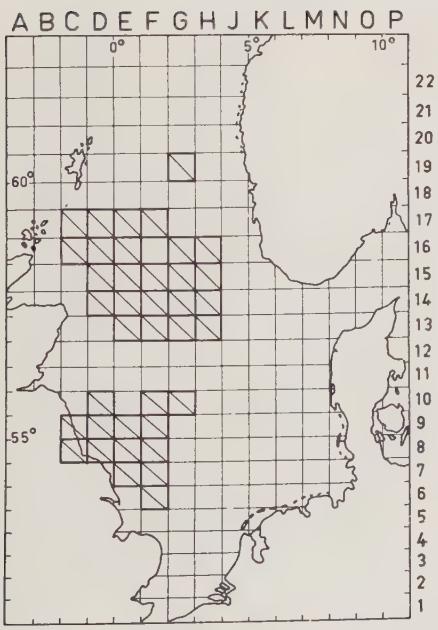


Figure 5 (c).

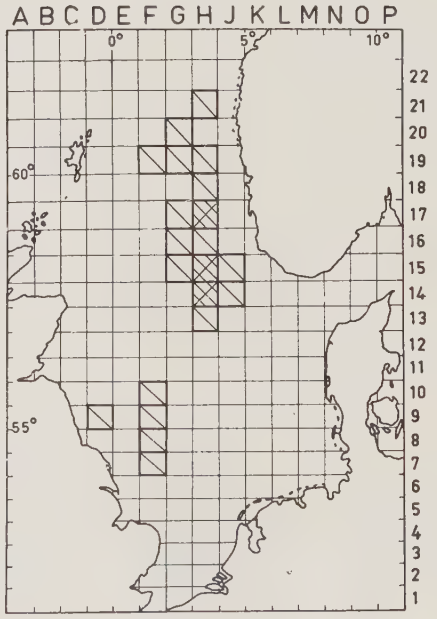


Figure 5 (d).

Figures 5 (a—d). Netherlands; landings of whiting by herring trawlers at IJmuiden in 1957, for each quarter of the year.

servations on commercial vessels. Market measurements of landed haddock and whiting.

Sweden. No information.

France. Percentage by weight of cod, haddock and whiting discarded at sea by Boulogne trawlers.

Poland. Quantities of discarded fish, by months and sub-regions.

Netherlands. Age and length composition of haddock from two commercial trawler trips. Market measurements of whiting.

Belgium. No information.

Thus the size composition of the total *catch* of haddock and whiting can be directly estimated only for Germany; however, as the fisheries of the Netherlands, Belgium, and Poland are known to be distributed in approximately the same areas as those of Germany (see paras. B. 5 and B. 6) it will be assumed provisionally that the German size composition data are applicable also to these fisheries. Whiting and haddock are now treated separately.

B. 17. Whiting by-catch (German data)

From an analysis by Sahrhage (1959) of the *German* experimental catch data for 1955, 1956, and 1957 the following conclusions can be drawn concerning the number and sizes of fish caught, discarded, and landed by German herring trawlers. It should be noted here that the ratio of weight to length implied in Sahrhage's figures seems to be rather lower than that usually found for whiting, and it may be that his estimates of numbers are a little too high as a result. It was decided, however, to use Sahrhage's figures as they stand rather than to attempt to adjust them, since for the present purposes it seems better where doubt exists to use data which tend, if anything, to overestimate the by-catch and its effect, rather than the reverse.

(a) *North-eastern North Sea (IV a); spring fishery (Viking Bank, Utsira).* Nearly all whiting caught are above 20 cm; of these, nearly all up to 30 cm are discarded and also the greater part of those between 30 cm and 40 cm. Quantities are as follows (German contribution, Table 27):—

Table B.7

	Tons	Number of fish (millions)
Total catch	2,075	17
Above min.size (20 cm)	2,072 (99·8 %)	16·9 (99 %)
Below min.size (20 cm)	3 (0·2 %)	0·1 (1 %)
Landed catch ('52–'56)	415 (20 %)	1·7 (10 %)
Discarded catch	1,660 (80 %)	15·3 (90 %)

(b) *Northern North Sea (IVa), summer fishery (Fladen); plus middle North Sea (IVb), summer-autumn fishery (Gut-Dogger).* Catches of whiting between 10 cm and 20 cm may be considerable (e.g., 1957) especially in the Dogger area. Quantities as follows (German contribution, Table 28):—

Table B.8

	Tons	Number of fish (millions)
Total catch	2,280	20·0
Above 20 cm	2,120 (93 %)	16·0 (80 %)
Below 20 cm	160 (7 %)	4·0 (20 %)
Landed catch ('54–'56)	114 (5 %)	0·2 (1 %)
Discarded catch	2,166 (95 %)	19·8 (99 %)

(c) Percentage size compositions are available for the *Fladen and Dogger area separately*, as follows:—

Table B.9

	% by weight	% by numbers
Fladen (IVa)		
Above 20 cm	98	86
Below 20 cm	2	14
Landed catch	4	1
Discarded catch	96	99
Dogger (IVb)		
Above 20 cm	89	72
Below 20 cm	11	28
Landed catch	6	1
Discarded catch	94	99

Note: Percentages for Fladen are straight averages of 1956 and 1957; for Dogger, straight averages of 1955, '56, and '57.

(d) For later purposes it is necessary to have also the total size composition data for Germany, i.e. all areas combined. This is as follows:—

Table B.10

	Tons	Number of fish (millions)
Total catch	4,355	37·0
Above 20 cm	4,192	32·9
Below 20 cm	163	4·1
Landed catch ('52–'56)	529	1·9
Discarded catch	3,826	35·1

(e) *Conclusions from the above tables.* It must be remembered that these data are deduced from comparison of experimental catches with commercial landings; also, they refer to two or three years only, so that they are likely to be influenced considerably by year-class strength. Nevertheless, they give a consistent picture of a north to south gradation in the proportion of undersized whiting caught, ranging from 1 % in the Viking Bank area to 30 % on the Dogger. These figures are now compared with such information as is available on the by-catch of whiting landed by other countries.

B. 18. Whiting by-catch (data of other countries)

(a) *France.* Table C of the French contribution gives an estimate of 2 % for the proportion by weight of by-catch discarded at sea from Boulogne trawlers.

This agrees with the percentage by weight below minimum size in the German catches for the Viking and Fladen areas and indicates that, unlike the practise in Germany, very little, if any, of the French by-catch of legal sized whiting is discarded.

(b) *Poland.* No information by species is available, but the proportion of the total gadoid by-catch discarded in Region IVb is considerably greater than in IVa, which is in general agreement with the German observations if it is assumed that the greater part of the gadoid by-catch is whiting.

(c) *Netherlands.* The Netherlands contribution gives size compositions of market landings of whiting by trawlers from north of 56° N (i.e., mainly IVa), which is the by-catch whiting from the Netherlands adult herring/mackerel fishery in this area. This is shown in Figure 6, together with the size composition of German whiting landings from the same area and as nearly as possible from the same period (1957). In this diagram the percentage of fish above 40 cm from the two countries has been adjusted to equality, so that the relative proportions of smaller fish can be properly assessed. It is clear that the discarding procedure is very different in the two countries, and for each ton of whiting caught by the two countries, the proportion retained by the Netherlands compared with Germany is thirteen times as high by numbers and seven times as high by weight.

B. 19. Whiting; estimated by-catch of countries separately, by sizes

(a) Because of the evidence of a considerable localization of whiting stocks which is emerging from current investigations, an attempt is made to estimate the total by-catch by areas as far as possible. From the Netherlands charts and information from other countries, it is evident that there is a close association between the areas of the adult herring/mackerel fisheries and the time of year. Where specific information on origin of catch is lacking, this association is therefore used to estimate from Tables B. 4 and B. 5 how much has been caught in the various areas, as follows:—

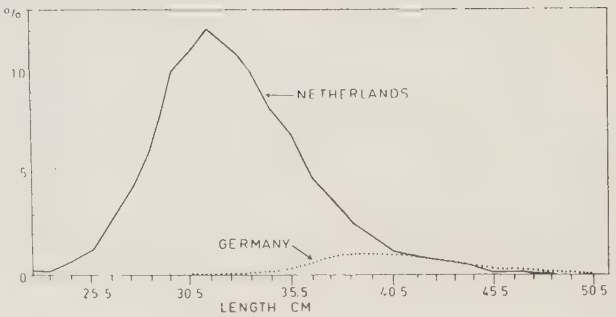


Figure 6. Length composition of landings of by-catch whiting in Netherlands and Germany taken in adult herring/mackerel fisheries in 1957.

Month	Fishing area
January–April	Viking Bank; Utsira (IVa)
May–July	Fladen (IVa)
August–October	Gut and Dogger (IVb)
November–December*)	Viking Bank; Utsira (IVa)

*) Because hardly any by-catch is taken in the Channel fishery, all the by-catch data are allocated to Viking Bank/Utsira in these two months.

(b) *Germany.* The basic data for Germany have already been given in para B. 17, but shown here are figures taken from Tables B. 4 and B. 5 broken down by areas as described above and with catches increased by 8 % to allow for luggers fishing with herring trawls.

(c) *Netherlands.* By adopting the following procedures a similar table can now be constructed for the Netherlands:—

(1) Same conversion factors, weight to numbers, as in the table below.

(2) Same subdivision of catch into below and above 20 cm, as in the table below.

Table B.11
Whiting by-catch (Germany)

Area	Total landed whiting (tons)	Raising factor, landings to catch	Total catch		Catch above 20 cm		Catch below 20 cm	
			Tons	Millions of fish	Tons	Millions of fish	Tons	Millions of fish
Viking and Utsira	506	5	2,530	20·7	2,525	20·5	5	0·2
Fladen	72	25	1,800	15·8	1,764	13·6	36	2·2
Gut and Dogger	45	17	760	6·7	676	4·8	84	1·9
Total	623	—	5,090	43·2	4,965	38·9	125	4·3

Notes:
(i) Conversion of weight to numbers taken from data of Tables B.7 and B.8.
(ii) Subdivisions of total catch into above and below 20 cm taken from data of Tables B.7 and B.9.

Table B.12
Whiting by-catch (Netherlands)

Area	Total landed whiting (tons)	Raising factor, landings to catch	Total catch		Catch above 20 cm		Catch below 20 cm	
			Tons	Millions of fish	Tons	Millions of fish	Tons	Millions of fish
Viking and Utsira	2,014	1·25	2,520	20·6	2,515	20·4	5	0·2
Fladen	551	2	1,100	9·7	1,078	8·3	22	1·4
Gut and Dogger	716	3	2,150	19·0	1,914	13·7	236	5·3
Total	3,281	—	5,770	49·3	5,507	42·4	263	7·9

(3) Raising factors—landings to catch—based on a combination of Table B. 11, information in para B. 18 (c) and a comparison of Netherlands market measurements with German experimental catches by areas.

(d) *France.* No area breakdown is possible, but the total quantity of whiting caught above and below 20 cm can be estimated if it is assumed that only fish below 20 cm are rejected. It was shown in para. B. 18(a) that this assumption is in harmony with the size-composition data of other countries, especially for the northern fishing grounds.

Thus, from the data of Table B. 3, and using the relation between weight and numbers from the German data of Table B. 10, the following table can be constructed for France:—

Table B.13
Whiting by-catch (France)

	Tons	Millions of fish
Total landings (taken as catch above 20 cm)	11,000	86
Rejected (= 2 %) (taken as catch below 20 cm)	220	6
Total catch	11,220	92

(e) *Poland.* Since no information for whiting separately is available, figures for Poland have been estimated by raising the German whiting catches according to the proportion of herring landed by the two countries.

It should be noted that the by-catch of whiting by Poland estimated in this way is somewhat less than corresponding figures for total gadoid by-catch given in the Polish contribution, as should be the case.

(f) *Belgium.* As no discard data are available for Belgium, and the proportion rejected varies so greatly between countries, a rough estimate of the Belgian whiting by-catch has been obtained by raising from the German data, as was done for Poland above. There is no record of a Belgian fishery in the Viking/Utsira area. Data for October is included in the Fladen area catches (Belgian information supplied later on request).

(g) *Sweden.* In the absence of any information on the distribution of the Swedish adult herring fishery in the North Sea, but knowing that this must differ considerably from that of other countries, we do not attempt to estimate size compositions of the Swedish by-catch of whiting.

B. 20. Summary of whiting by-catch for all countries

(a) From the tables of para. B. 19, estimates of the total by-catch of whiting above and below 20 cm by areas can be arrived at for all countries except France and Sweden. Data for France can, however, be included in the total for all areas shown in the last row (bearing in mind the qualification regarding the French whiting catch in note (c) of Section B. 9).

Some observations on Table B. 16 are as follows:—

(b) Most of the estimates comprising this table

Table B.14
Whiting by-catch (Poland) (1957)

Area	A	B	C	Estimated Polish catch of whiting using raising factors of column C			
	Polish catch of herring (tons)	German catch of herring (tons)	A/B	Above 20 cm		Below 20 cm	
				Tons	Millions of fish	Tons	Millions of fish
Viking and Utsira	2,021	7,279	0·28	706	5·7	1·4	0·06
Fladen	14,939	19,919	0·75	1,320	10·2	27	1·6
Gut and Dogger	21,875	107,628	0·20	135	1·0	17	0·4
Total	38,835	134,826		2,161	16·9	45·4	2·06

Table B.15
Whiting by-catch (Belgium) (1954–1957)

Area	A Belgian catch of herring (tons)	B German catch of herring (tons)	C A/B	Estimated Belgian catch of whiting, using raising factors of column C			
				Above 20 cm		Below 20 cm	
				Tons	Millions of fish	Tons	Millions of fish
Fladen	417	19,919	0·02	35	0·3	0·7	0·04
Gut and Dogger	659	107,628	0·006	20	0·15	2·5	0·05
Total	1,076	127,547		55	0·45	3·2	0·09

Table B.16
Whiting by-catch from adult herring, mackerel fisheries. Landings and estimated catches by all countries except Sweden; average for years 1954–1957 where possible

Area	Total landings (tons)	Total catch		Catch above 20 cm		Catch below 20 cm	
		Tons	Millions of fish	Tons	Millions of fish	Tons	Millions of fish
Viking to Utsira	2,900	5,800	47	5,700	47	11	0·5
Fladen	1,400	4,300	38	4,200	32	86	5·2
Gut and Dogger	800	3,100	27	2,700	20	338	7·6
Total (including France)	16,000	24,300	204	23,700	185	655	20

are based in the first instance on the German size-composition data which, as mentioned above, refer to two years (1956 and 1957 mainly) and so are bound to be influenced to some extent by year-class variation.

(c) It will be noted that nearly half the total catch of whiting is taken by France, so that if French fishing is distributed as is that of other countries, the total catches in each area will also be nearly double those given in the table.

(d) Bearing in mind these and other relevant qualifications, it is nevertheless believed that the catches of whiting given in this table are sufficiently reliable to make it worthwhile to attempt at least a provisional assessment of their effect on the whiting stocks.

B. 21. Comparison of whiting by-catch with total whiting landings by trawls with Convention meshes

The average total whiting landings from the North Sea in 1954, 1955, and 1956 were 71,000 tons (Bull. Stat.), a figure which includes the 16,000 tons in Table B. 16 above. Thus the estimated quantity of whiting *landed* as by-catch from the mixed adult herring/mackerel fisheries is between one-fifth and one-quarter by weight of the total landings; the estimated quantity of legal-sized whiting *caught* in these fisheries (23,700 tons) is about one-third of the total landings.

B. 22. Assessment of effect of whiting by-catch; General

The next question to be considered is that of estimating the effect of the whiting by-catch from the adult herring/mackerel fisheries with small-meshed trawls, relative to that of the Convention whiting fisheries of the North Sea (i.e., those with Convention meshes). For this purpose it is necessary to treat the whiting by-catch in three parts, viz: —

(a) Fish below the minimum legal size of 20 cm.

(b) Fish above the minimum legal size, but yet small enough to escape through Convention meshes.

(c) Fish large enough to be retained by Convention meshes.

In making the assessments it will be assumed that if the same vessels as are at present using small-meshed gear for this kind of mixed fishing were to be using Convention meshes instead, then no fish of either category (a) or (b) above would be caught, but the catch of fish of category (c) would remain unchanged. This latter is, of course purely an assumption, because it is impossible to predict how the fishing tactics of the vessels would change if they were to use Convention meshes, and their catches of category (c) whiting might either increase or decrease; nevertheless, to take it that the catch of category (c) whiting would stay the same is a reasonable basis on which to make the required assessments. Thus the problem to be considered is essentially one of assessing the effect of the capture of by-catch whiting of categories (a) and (b) above. It will be noted in this connexion that category (b) is important for whiting because the present minimum legal size of 20 cm is below the selection range of Convention meshes.

B. 23. Assessments for by-catch whiting of category (a) (below 20 cm)

(a) In these and similar assessments it is sometimes necessary to make certain assumptions where precise information is lacking. Where appropriate the procedure in these circumstances will be to use two estimates; (i) one which is thought to be the most likely and reasonable value, and (ii) a value which is probably near the limit of the possible range, and is such as to tend to produce a maximum estimate of the effect of the capture of by-catch whiting by small-meshed gears.

(b) From Table B. 16 it is estimated that the average total annual by-catch of undersized whiting is 655 tons or 20 million fish. The average weight of individual undersized fish is thus

$$\frac{655}{20} = 33 \text{ g}$$

and taking a weight-length[3] factor for ungutted whiting of $K = 0{\cdot}009$ enables their average length to be calculated as

$$\text{Average length} = \sqrt[3]{\frac{33}{0{\cdot}009}} = 15 \text{ cm}$$

which is a reasonable figure.*)

(c) If these fish had not been caught, and if they had subsequently entered Convention mesh fisheries, they would have done so at a length of about 27 cm, on average (i.e., the 50 % selection length of the Convention mesh, see *Ad Hoc* Report). From data on the growth-rate of whiting in the north and central North Sea (Sahrhage, Mestorff, Ellis and Jones), it can be estimated that the growth between 15 cm and 27 cm is accomplished in about 1½ years, on average, with 1 year as the minimum value.

(d) No direct estimate of the natural mortality rate of whiting during this early period of life is available, and in reality it is probably greater among the smallest fish than among those approaching the size at entry to the Convention fisheries. Having in mind the findings of Ellis and Jones (1956) that a value of up to 20 % per year is not inconsistent with recent changes in the Convention fisheries of the northern North Sea, an average value of 30 % per year over the span of length from 15 cm to 27 cm is not likely to under-estimate the true natural mortality rate of these whiting.

*) It is not overlooked that the average length of a group of fish does not correspond precisely in this way to the average weight, but the discrepancy is small over the relatively short spans of length involved in these and subsequent calculations.

(e) Taking, therefore the span of life between 15 cm and 27 cm as 1½ years, this estimate of natural mortality means that the 20 million fish would have been reduced to about 12 million reaching 27 cm if they have not been caught. The maximum estimate from the alternative values, is 16 million.

(f) It remains to estimate the total number of fish entering the Convention fisheries at 27 cm. From the available size-composition data of whiting caught by Convention meshes (see Part II of this Report), it would seem that a modal length of about 30—32 cm and an average weight of about 250 g can be taken as fairly representative of the whiting landed from the Convention fisheries. Thus, the total landings of 71,000 tons (para. B. 21) correspond to something in the region of

$$\frac{71{,}000 \times 1{,}000{,}000}{250} = 280 \text{ million fish.}$$

To calculate how many fish are recruited annually to these whiting fisheries it is necessary to multiply this catch by the average ratio of the total mortality to the fishing mortality in the stocks. This ratio probably varies in different parts of the North Sea. For the main Convention fisheries of the northern North Sea, Ellis and Jones (1956) concluded that fishing mortality was in the region of about four-fifths of the total mortality, but whiting are widespread and the average fishing intensity is unlikely to be as high as this. To take fishing as about two-thirds of the total mortality, (see *Ad Hoc* Report) would seem a better average ratio, in which case a catch of 280 million fish means that an average of roughly

$$280 \text{ million} \times 3/2 = 420 \text{ million}$$

fish enter these fisheries at an average length of 27 cm each year. Even this figure is likely, if anything, to be an underestimate.

(g) Thus, if the total by-catch of undersized whiting in the adult herring fisheries with small-meshed gear had been allowed to survive, they would represent the fraction

$$\frac{12}{420} = 3\,\%$$

of the total number of fish at present entering the Convention fisheries each year. A maximum figure would be about

$$\frac{16}{420} = 4\,\%.$$

(h) The question of whether the above percentages are to be regarded as true reductions of the Convention fisheries depends on whether all the undersized by-catch whiting would, in fact, have migrated into the main areas of these fisheries if they had not been caught. To the extent that they would not have done so, the true reduction of the Convention fisheries will be less than these percentages, which are therefore to be regarded, in this respect at least, as maximum values.

B. 24. Assessments for by-catch whiting of category (b) (between 20 cm and 27 cm)

(a) These can be carried through in the same way as for category (a) whiting, but first it is necessary to estimate the total number of fish caught comprising category (b) (i.e., in the size range 20—27 cm).

(b) From the size-composition data given in the German contribution for each area (see para. B. 17), approximate estimates can be obtained for the fraction of the total whiting catch above 20 cm that lies between 20 cm and 27 cm in each area. These are as follows:—

Viking and Utsira: 0·20
Fladen: 0·35
Gut + Dogger: 0·50

(c) If it is now assumed that the distribution of French by-catch whiting between the three areas is the same as that of other countries, the total catches of whiting above 20 cm in each area can be estimated by doubling the figures given in Table B. 16. Applying the above fractions to the resulting estimates gives the following figures for the by-catch of category (b) whiting in each area:—

Viking and Utsira: 19 million fish
Fladen: 22 million fish
Gut and Dogger: 20 million fish

and hence a total of 61 million fish.

(d) The average length of these category (b) fish will be less than 27 cm (probably about 25 cm), so that if they had not been caught, some would have died from natural causes before reaching 27 cm. A reasonable estimate is that this mortality would be about 10 %, so that about 55 million would have survived to reach a length of 27 cm.

(e) Thus, if the total by-catch of whiting of category (b) in the adult herring fisheries had been allowed to survive they would represent approximately the fraction

$$\frac{55}{420} = 13\,\%$$

of the total number of fish at present entering the Convention fisheries each year. The same considerations concerning the true effect on the Convention fisheries apply as in para B. 23 (h).

B. 25. Assessments for total whiting by-catch below 27 cm

(a) By adding together the percentages arrived at in para. B. 23 (h) and B. 24 (e), the total whiting by-catch of the adult herring/mackerel fisheries which results from the use of meshes smaller than the Convention size by all countries except Sweden represents the fraction

$$4\,\% + 13\,\% = 17\,\%$$

of the fish which enter the Convention fisheries. For the reasons given previously, this can be taken as a maximum effect of the estimate on the yield of whiting above 27 cm, and is equivalent to

$$\frac{17}{100} \times 71{,}000^{*}) = 12{,}000 \text{ tons.}$$

(b) No comprehensive statistics are available for Sweden, the only data available being those for landings at Gravarne and Smögen (Table B. 3). Judging by these figures, the percentage of by-catch in the Swedish landings is not greater than is the percentage in the total landings from the remaining countries. If, therefore, the preceding estimates of whiting by-catch and its effect relative to Convention fisheries are increased by the percentage which the Swedish landings are of the total for the remaining countries (about 12 %) the resulting figures make what is probably a maximum allowance for the addition of the total Swedish by-catch. Calculated on this basis, the total by-catch of whiting smaller than 27 cm becomes equivalent to about 19 % of the annual recruitment to the North Sea Convention whiting fisheries in recent years, or a catch as adult fish in the region of 13,500 tons per year.

(c) It must be understood, however, that this figure as it stands is not the actual loss of yield of whiting due to the small-meshed herring fisheries, because part of the catch of category (b) whiting is, in fact, landed (especially by France). Very roughly, this amount can be put at about 3,500 tons, so the

*) Strictly, this figure of 71,000 tons includes the 16,000 tons of legal sized whiting caught by small-meshed gears (see Table B. 16), and some of these fish would be too small to be retained by Convention meshes. On the other hand, it is known that there is some discarding by some countries of the smaller whiting taken by Convention meshes. No precise allowance can be made for these two factors on the available data, but they are opposing in their effects, and it is thought that the figure of 71,000 tons as it stands is a reasonable estimate of the catch taken by Convention methods, and will also have led to a reasonable estimate of recruitment (p. 20).

"nett loss" is perhaps about 10,000 tons. This "nett loss" is the result of the fish being caught by the small-meshed nets while still small in comparison with the size to which they could grow if allowed to survive to enter the Convention fisheries; it could appropriately be called "nett-wastage". Bearing in mind the limitation and uncertainties of the data used, it will be appreciated that the estimate can only be regarded as indicating the order of magnitude of the wastage.

(d) The combined numbers of categories (a) and (b) by-catch whiting caught in each of the three areas is very nearly the same (see Table B. 16 and para. B. 24 (c), the numbers of category (a) whiting being much the smaller and coming mainly from the Gut and Dogger). Thus it follows that the small-meshed adult herring fishery in each of these areas is responsible for about the same fraction of the total wastage.

(e) In the present state of knowledge on the migrations and identity of whiting stocks, it is not possible to estimate how the effect of the adult herring/mackerel fisheries is distributed over the Convention whiting fisheries of the various countries.

B. 26. Haddock by-catch; General

A summary of the information available on the haddock by-catch from the adult herring/mackerel fisheries has been given in para. B. 16. This is a little less complete than the whiting data, but for making assessments the same general procedure can be adopted as in the preceding paragraphs.

B. 27. Haddock by-catch; (German data)

From an analysis of the German experimental catch data for 1955, 1956, and 1957 by Sahrhage (1958), referred to in the German contribution, the following tables can be presented, giving the number and sizes of haddock caught, rejected, and landed by German herring trawlers. These tables follow the same layout as those presented in para. B. 17 for whiting.

(a) *North-eastern North Sea (IVa); spring fishery; Viking Bank, Utsira.* A considerable fraction of the haddock by-catch is between 15 cm and the Convention size limit of 27 cm. Nearly all fish up to 30 cm are discarded, and also the greater part of those between 30 cm and 35 cm. Quantities are as follows:—

Table B.17

	Tons	Number of fish (millions)
Total catch.....	483	2·1
Above min. size (27 cm)...	386 (80 %)	1·1 (52 %)
Below min. size (27 cm) ...	97 (20 %)	1·0 (48 %)
Landed catch ('52–'56) ...	290 (60 %)	0·6 (28 %)
Discarded catch.....	193 (40 %)	1·5 (72 %)

(b) *Northern North Sea (IV a), summer fishery (Fladen); plus Middle North Sea (IV b), summer-autumn fishery (Gut-Dogger).* Catches of haddock between 10 cm and 27 cm are highly variable but may be considerable. Discarded sizes are as in Viking area. Quantities are as follows:—

Table B.18

	Tons	Number of fish (millions)
Total catch.....	2,944	13·7
Above 27 cm	2,208 (75 %)	7·8 (57 %)
Below 27 cm	736 (25 %)	5·9 (43 %)
Landed catch ('54–'56) ...	942 (32 %)	2·2 (16 %)
Discarded catch.....	2,002 (68 %)	11·5 (84 %)

(c) Percentage size compositions are available for the *Fladen and Dogger areas separately*, as follows:—

Table B.19

	% by weight	% by numbers
	Fladen (IVa)	
Above 27 cm	76	56
Below 27 cm	24	44
Landed catch.....	30	13
Discarded catch.....	70	87
	Dogger (IVb)	
Above 27 cm	73	59
Below 27 cm	27	41
Landed catch.....	34	19
Discarded catch.....	66	81

Note: Percentages for both areas are straight averages of years 1955, 1956, and 1957.

(d) For later purposes the total size-composition data for Germany, i.e. all areas combined, will be needed also; these are as follows:—

Table B. 20

	Tons	Number of fish (millions)
Total catch.....	3,427	15·8
Above 27 cm	2,594 (76 %)	8·9 (56 %)
Below 27 cm	833 (24 %)	6·9 (44 %)
Landed ('52–'56).....	1,232 (36 %)	2·8 (18 %)
Rejected ('52–'56).....	2,195 (64 %)	13·0 (82 %)

(e) *Conclusions from the above tables.* In contrast to the result for whiting (para. B. 17 (e)), these data show that for the haddock by-catch the proportion of undersized fish is least in the South (41 %) (Dogger) and greatest in the North (Viking) (48 %), although the differences between the areas are much less than in whiting.

B. 28. Haddock by-catch; data of other countries

(a) *France.* Table C of the French contribution gives an estimate of 6 % for the proportion by weight of by-catch haddock discarded at sea from Boulogne trawlers. This is very much less than (about $^1/_{10}$ of) the percentage discarded in the German fishery, and it is about $^1/_4$ of the estimated percentage of undersized fish in the German by-catch of haddock. As in the case of whiting, several types of trawls, particularly whiting trawls, are used, but the breakdown is not known.

(b) *Poland.* No direct information by species is available, but it is probable that the haddock by-catch is minor compared with whiting (see para. B. 18 (b)).

(c) *Netherlands.* No market sample data are available (unlike whiting) but the length composition of the haddock by-catch on two commercial trips in 1958 in the Viking area was given in material submitted to the scientific sub-committee at The Hague (see also the Netherlands contribution). These data gave relatively fewer undersized fish than in the German data for 1956 and 1957, but showed that a similar range of length of fish is discarded. The difference in proportion of undersized fish could be explained by the strong 1955 year-class.

B. 29. Haddock, estimated by-catch of various countries, by sizes

(a) Owing to the less complete data for the haddock by-catch, it is not possible to construct tables of the size composition in each area for all countries as is done for whiting in para. B. 19. The distinction between countries may be less important for haddock than for whiting, however, because on the evidence available there do not seem such great differences between countries in the discarding of haddock (except perhaps for France) as there are for whiting.

(b) For those three countries for which monthly data are available (Germany, Netherlands, and Belgium) estimates can be obtained of the total haddock by-catch by areas and sizes, analogous to those for whiting of Table B. 16. The same association between season and area is used and, as for whiting, figures for total landings by areas are obtained from Tables B. 4 and B. 5. Although slight differences in mesh size may influence these figures, the German size-composition data are taken as applicable to the catches of the other two countries.

(c) *Poland.* Because for Germany and Poland the by-catch of haddock is incidental (in contrast to the Netherlands), the Polish by-catch of haddock is estimated by raising the German haddock figures according to the relative quantity of herring caught by the two countries (Germany and Poland).

From Table B. 1, the herring catches give a raising factor of

$$\frac{41{,}000}{183{,}000} = 0{\cdot}22$$

The German by-catch of haddock is 3,400 tons (see Table B. 20), from which the Polish haddock by-catch is estimated as

$$0{\cdot}22 \times 3{,}400 = 760 \text{ tons.}$$

A check that this is a reasonable figure can be obtained by adding it to the estimated Polish by-catch of whiting of 2,206 tons (Table B. 14), giving a total of 2,966 tons. This is a little less than the total gadoid by-catch by Poland of 3,029 tons (see Polish contribution), as should be the case.

(d) *France.* From Table B. 3, the landings of French by-catch haddock are 3,300 tons, and a further 6 % by weight is discarded (see para. B. 28 (a)). Hence the total catch can be estimated as about 3,500 tons.

B. 30. Haddock by-catch (all countries)

If it is asumed that the size composition of the Polish haddock by-catch is the same as that for Germany, and that all the French by-catch of haddock

Table B. 21
Estimated size composition of haddock by-catch by Germany, Netherlands, and Belgium

Area	Total landings of by-catch haddock (tons)	Raising factor, landings to catch	Total catch		Catch above 27 cm		Catch below 27 cm	
			Tons	Millions of fish	Tons	Millions of fish	Tons	Millions of fish
Viking and Utsira	4,210	1·67	7,030	30·6	5,620	16·0	1,610	16·6
Fladen	2,722	3·33	9,064	54·6	6,890	23·6	2,176	31·0
Gut and Dogger	3,294	2·96	9,684	45·1	7,070	26·6	2,614	18·5
Total	10,200		25,800	132	19,600	66	6,200	66

Table B. 22
Haddock by-catch from adult herring/mackerel fisheries; estimated landings and catches, all countries except Sweden

Country	Total landings of by-catch haddock (tons)	Total catch		Catch above 27 cm		Catch below 27 cm	
		Tons	Millions of fish	Tons	Millions of fish	Tons	Millions of fish
Germany + Netherlands + Belgium	10,226	25,778	132	19,580	66	6,198	66
Poland	270	760	3·9	580	2·0	180	1·9
France	3,300	3,500	13·3	3,300	11·1	200	2·2
Total	13,800	30,100	149	23,500	79	6,600	70

above 27 cm is retained, total figures for all countries except Sweden can be estimated, and are as shown in Table B. 22.

Some observations on this table are as follows:—

(a) As in the case of whiting, most of the estimates comprising this table are based in the first instance on the German size-composition data which refer to three years only (1955, 1956, and 1957) and so are bound to be influenced to some degree by year-class variation.

(b) About three-quarters of the total haddock by-catch as estimated above is caught by the Netherlands (see also Table B. 3). This contrasts with the situation for whiting, of which France takes the largest part and Germany and the Netherlands take roughly equal shares.

(c) In the absence of direct information either on the discarding of haddock at sea by the Netherlands (except for a few data mentioned in paragraph B. 28 (c)) or the length composition of by-catch haddock landed by the Netherlands, this is assumed to be the same as in the German fishery. If this should not be true, then almost certainly the Netherlands discarding will be less than the German; to the extent that this is the case, the estimated total by-catch of haddock in Tables B. 21 and B. 22 may be too great.

(d) It is nevertheless believed that, as with whiting, the estimates of haddock by-catch given in Table B. 22 can provide a sufficient basis for making a provisional assessment of the effect relative to the haddock stocks.

B. 31. Comparison of haddock by-catch with total haddock landings by trawls with Convention meshes

The average total haddock landings from the North Sea in 1954, 1955, and 1956 were 84,000 tons, which includes the figure of 13,800 tons in Table B. 22. Thus the quantity of haddock landed from the mixed adult herring/mackerel fisheries is about one-sixth by weight of the total landings.

B. 32. Assessment of effect of haddock by-catch; General

To estimate the effect of the haddock by-catch from the adult herring/mackerel fisheries using small-meshed trawls on the haddock fisheries of the North Sea using trawls with Convention meshes, it is necessary as before to divide the by-catch into three components on the basis of length. For haddock, however, the definition of all three categories is different from those used for whiting, and is as follows:—

Category (a). Fish below the 50 % retention length of Convention meshes (= 24 cm).
Category (b). Fish between 24 cm and the minimum legal size of 27 cm.
Category (c). Fish above 27 cm.

This difference between the definition of the three categories in the two species arises because whereas in whiting the minimum legal size is below the selection range of Convention meshes, that of haddock is at the upper limit of the selection range. Thus, haddock of category (a) would not be retained by Convention meshes; those of category (b) would be retained but discarded as undersized; while haddock of category (c) would be retained by Convention meshes and would be marketable.

With the same argument as set out in paragraph B. 22 for whiting, it therefore follows that the problem in the case of haddock reduces to one of assessing only the effect of the capture of by-catch haddock of category (a) above.

B. 33. Assessments for by-catch of category (a) haddock (below 24 cm)

(a) Estimates of the total by-catch of haddock below 27 cm (i.e., categories (a) + (b)) are given in Table B. 22. It is necessary to estimate what fraction of this consists of category (a) fish (below 24 cm). The only information on this is the German length-composition data (referred to in para. B. 27), and this gives rather variable estimates. Two estimates are therefore used, between which the true value is likely

to be. For the lower estimate the ratio by numbers of category (a) fish to category (b) fish is taken as 1:1, and for the higher estimate 4:1. From Table B. 22 this gives estimates

$$1/2 \times 70 \text{ million} = 35 \text{ million (lower estimate)}$$

and

$$4/5 \times 70 \text{ million} = 56 \text{ million (higher estimate)}$$

for the total numbers of category (a) fish.

(b) It is now necessary to calculate the average length of category (a) fish, which will differ somewhat according to which of these two estimates is used. From Table B. 22 the average weight of all fish below 27 cm (categories (a) + (b)) is

$$\frac{6{,}600}{70} = 94 \text{ g.}$$

The average length of category (b) fish can be taken as about 25·5 cm, and with a weight/length factor of $K = 0{\cdot}0082$, this corresponds approximately to an average weight of

$$(25{\cdot}5)^3 \times 0{\cdot}0082 = 136 \text{ g.}$$

Thus with the lower estimate of numbers of category (a) fish (35 millions) their average weight can be estimated as

$$\frac{(94 \times 70) - (35 \times 136)}{35} = 53 \text{ g}$$

which corresponds approximately to a length of 18·5 cm. With the higher estimate of 56 million, the average weight is

$$\frac{(94 \times 70) - (14 \times 136)}{56} = 84 \text{ g}$$

corresponding to a length of 22 cm.

(c) If these category (a) fish had not been caught but had subsequently entered Convention mesh fisheries, they would have done so at a length of 24 cm, on average. For the lower estimate of 35 million fish at 18·5 cm, this span of length (18·5 to 24 cm) would occupy about 8 months. For the higher estimate of 56 million fish at 22 cm, the growth of 2 cm to a length of 24 cm would be accomplished in about 3 months. (Growth estimates from data submitted to the *Ad Hoc* Committee.)

(d) The natural mortality rate of haddock over these spans of length can reasonably be taken as not less than about 20 % per year (*Ad Hoc* Report). Hence from the lower estimate of numbers, the number of fish which could have survived to enter the Convention fisheries can be estimated as about 30 million. From the higher estimate the number is about 53 million.

(e) The next stage is to estimate the total number of fish entering the Convention fisheries at 24 cm. This is best done by first estimating the number reaching marketable size at 27 cm, and from Table B. 22 the average weight of marketable by-catch haddock is

$$\frac{23{,}500}{79} = 300 \text{ g}$$

corresponding to an average length of about 33 cm. From the Scottish research vessel data given in the U. K. contribution for the years 1954/57, the average length of marketable haddock is about 31 cm. This is a little lower than that derived from the German by-catch data, and is probably a reflection of area differences in the size composition of the stocks. Sahrhage (1958) also quotes Jones' data for the length composition of Scottish market landings for 1955 and 1956, in which the average is about 34 cm. This higher value can be seen from the data to be due partly to the discarding of fish immediately above the size limit, which perhaps amounts to about $^1/_5$ by numbers of the total catch above 27 cm by all countries. Thus, it is consistent if the average length of haddock in the landings in the Convention fisheries is taken as about 34 cm, and that these represent about $^4/_5$ of the true number caught. In this way the number of fish landed from the Convention fisheries can be estimated from the total weight landed (84,000 tons) divided by the weight of a fish of 34 cm, i.e.

$$\frac{84{,}000}{0{\cdot}0082 \times 34^3} = 260 \text{ million fish}$$

so that the total number caught is

$$260 \text{ million} \times {}^5/_4 = 325 \text{ million fish}$$

(f) Taking the ratio of fishing to total mortality for haddock in the Convention fisheries as $^4/_5$ (*Ad Hoc* Report), a catch of 325 million fish means that an average of

$$325 \text{ million} \times {}^5/_4 = 406 \text{ million fish}$$

entered these fisheries each year at an average length of 27 cm. These fish will, however, have been liable to capture since they were 24 cm in length, on average; and taking about 5 months as about the time needed to complete this growth, and a fishing mortality rate of about 50 % per year or 25 % in 5 months, the total number of fish reaching 24 cm is estimated as

$$\frac{406 \text{ million} \times 100}{75} = 540 \text{ million fish.}$$

(g) The two estimates of the number of by-catch haddock which would have survived to 24 cm if they had not been caught in the adult herring/mackerel fisheries were 30 million and 53 million. These therefore represent the fractions

$$\frac{30}{540} = 6\,\%$$

and

$$\frac{53}{540} = 10\,\%$$

of the total number of fish at present entering the Convention fisheries at the 50 % length of 24 cm.

(h) As mentioned in paragraph B. 23 (h) for whiting, these percentages show the actual reductions of the Convention fisheries only if all the surviving by-catch haddock below 24 cm would, in fact, have entered these fisheries, and in this respect the above figures are to be regarded as maximum estimates. It is believed, however, that this assumption is more likely to be true for haddock than whiting, owing to the greater homogeneity of the haddock stocks.

(i) The above percentages also represent directly the "biological wastage" as defined in para. B. 25 (a), of haddock caused by the adult herring/mackerel fisheries. The higher percentage corresponds to a wastage of

$$10\,\% \times 84{,}000 = 8{,}400 \text{ tons per year.}$$

(j) From the data of fish below 27 cm shown in Table B. 21, and taking into account the different length distributions of these fish in the three areas, it can be estimated that roughly $^1/_6$ of this wastage occurs in the Gut and Dogger areas, about $^1/_3$ in the Viking area and $^1/_2$ in the Fladen.

(k) As in the case of the whiting estimates, the above figures for haddock do not include the by-catch taken by Sweden, for which no data are available except those referring to the ports of Gravarne and Smögen. If it is assumed, as before, that the Swedish by-catch is roughly the same fraction of the Swedish herring catch as is the case for all other countries taken together, the above estimates would need to be increased by about 12 %; this would make the total haddock by-catch equivalent to about 11 % of the recruitment to the Convention fisheries, as an upper figure, and it would constitute a wastage of about 9,500 tons per year.

B. 34. By-catch in North Sea adult herring/mackerel fisheries using pelagic trawl

A pelagic herring trawl is used by Belgium, Netherlands, and probably Germany in the Channel and Sandettié winter fisheries, and by Sweden and Denmark in the northern North Sea. France also uses this gear to some extent. By-catch quantities are available only from Belgium, but a rough indication of the total by-catch can be obtained by raising according to the herring landings of the countries concerned relative to those of Belgium. This gives the estimates:—

Table B. 23
Estimated by-catch from adult herring fisheries with pelagic trawl (Channel)

Country	Herring (tons)	Total demersal by-catch (tons)
Belgium	6,301	25
Netherlands	10,306	41
Germany	530	2
Total	17,137	68

Table B. 24
Quantities (tons) of herring and by-catch landed from the Swedish adult herring fisheries in the Skagerak and Kattegat (at the ports of Gravarne and Smögen)

Gear	Herring	Mackerel	Sprat	Cod	Haddock	Whiting	Industrial fish	Other and unidentified species
Bottom trawl	630	20	6	9	2	4	190	60
Pelagic trawl	6,800	140	13	1	—	4	215	115
Total	7,430	160	19	10	2	8	405	175

Some conclusions from this table are as follows:–

(i) The quantity of herring recorded in this table is about $^1/_4$ of the total Swedish landings of trawl-caught herring from this area.

(ii) Even with the bottom trawl, the recorded catch of cod, haddock, and whiting comprises only about 3 % of the herring catch. With the pelagic trawl the percentage is very small indeed.

(iii) It should be noted that the species composition of neither the "industrial fish" nor the "other species" is recorded. In the bottom trawl fishery these together comprise 40 % of the herring landings, and in the pelagic trawl fishery about 5 %. Raised to the total recorded catch of adult herring by Sweden in this area, the two categories amount to about 2,000 tons.

Table B. 25

Landings (tons) from adult herring/mackerel fisheries, including by-catch, in Region VII (bottom trawl)

Country	Herring	Mackerel	Cod	Haddock	Whiting	Hake	Other non-6	Origin of data
Belgium	2,556	19	27	1	112	?	81	1954–57 Contr.
Netherlands	2,364	4	—	—	52	2	—	1957 Contr.
Germany	879	—	—	—	28	—	—	1957 Jahresbericht
U.K.	400	—	—	—	20	—	—	1956 Contr.

Notes:

(i) The figure for Netherlands mackerel refers to all Article 6 species except herring.
(ii) The figure for United Kingdom whiting includes some haddock.
(iii) The figure for German whiting includes all species other than herring. The German fishery did not start until the end of 1957.

It is clear that on this evidence the by-catch with this gear is negligible, both in terms of percentage and quantity, compared with that taken by bottom herring trawl. Insufficient data are available for the pelagic trawl catches of Sweden and France, for any estimates to be made.

B. 35. Adult herring/mackerel fisheries in the Skagerak and Kattegat

(a) The quantities of adult herring landed from the Skagerak and Kattegat by Germany, Sweden, and Norway are given in Table B. 3. Only four countries are at present concerned, namely Germany, Sweden, Norway, and Denmark; of these, Swedish landings comprise about 80 % of the total.

(b) By-catch data are available only from the Swedish contribution and these refer to the ports of Gravarne and Smögen only. For the landings at these two ports by bottom trawl and pelagic trawl separately, the by-catch quantities are set out in Table B. 24 (quantitities in tons, average of years 1954 to 1956).

B. 36. Adult herring/mackerel fisheries in Region VII

(a) Some statistics of landings of herring and by-catch are available from Belgium, Netherlands, Germany, and the United Kingdom; France and Poland also have fisheries of this kind in Region VII, but no detailed statistics are available. For the first four of these countries, the data for bottom herring trawl are given in Table B. 25.

(b) Statistics for pelagic trawl are available from United Kingdom, 1957. Landings of herring totalled 350 tons, of which the gadoid by-catch was less than 15 tons.

(c) From the evidence available, the total by-catch of non-Article 6 species is less than 5 % for both gears. The quantity is negligible in comparison with the quantities landed by the Convention fisheries in this region.

(d) The main herring trawl fisheries of Region VII are in the Smalls and Dunmore areas, off the south-east coast of Ireland, and in the entrance to the Bristol Channel (VII g). The English pelagic trawl fishery is mainly in the Irish Sea (VII a).

C. Young Herring Fisheries

C. 1.

There are really two kinds of trawl fisheries for young herring. By far the most important is the "offshore" fishery, carried out by Denmark and Germany. In the North Sea, the offshore fishery is pursued mainly in the eastern part of the central North Sea, particularly on the eastern edge of the Dogger Bank (e.g., the Bløden Ground). The "inshore" fisheries for young herring are carried out in the coastal waters of Germany, the Netherlands, and probably of certain other countries, together with the sprat fisheries; these inshore fisheries amount to about 2 % of the total young herring fisheries.

C. 2.

Detailed information relating to the offshore young herring fisheries is given in Table C. 1.

C. 3. Distribution of young herring fisheries.

Figure 7 shows the origin of Danish landings of young herring from the North Sea in 1957. No detailed data on the distribution of the German young herring fisheries were available, but it can be taken that these occur in the same general area but are centred a little more to the south.

C. 4. Statistics of by-catch (North Sea)

(a) By-catch statistics are given for Germany in the publications referred to in connexion with Table C. 1 and in the German contribution.

(b) For Denmark the by-catch of whiting and the remaining non-Article 6 species is estimated from data on the quantities of these in the total industrial catch after subtracting the landings of them in the separate sand-eel fishery. Separate estimates for the

Table C. 1
Landings of herring in young herring fisheries

Country	Area	Tons	%	Years	Price	Price (sh./kr.)	Value ('000 shs.)
Denmark	North Sea	79,000*)	45	av. '55–'57	0·29 sh./kr.	0·29	23,000
	Skagerak + Kattegat	68,000*)	39	av. '55–'57	0·29 sh./kr.	0·29	20,000
Germany	North Sea	29,000	16	av. '54–'57	0·16 DM/kr.	0·27	9,400

*) Includes a small proportion of adult herring.
Sources of data:
Denmark: Quantities from Danish contribution (taking quantities used for reduction). Prices from Bull. Stat.
Germany: Quantities and prices from German contribution and publications by Tiews & Kühl.

Table C. 2
Quantities (tons) of herring and by-catch in the young herring fisheries of the North Sea (average annual values 1955–57)

Country	Total landings	Herring	Other Art. 6	Cod	Haddock	Whiting	Plaice	Dab	Other non-6	All non-6
Denmark	92,100	78,700	2,800	140*)	1,300*)	8,300	+*)	200*)	650*)	10,600
Germany	34,900	28,800	1,500	100	900	3,000	+	140	450	4,500
Total.....	127,000	107,500	4,300	240	2,200	11,300	+	340	1,100	15,100

Note: "Other Article 6" quantities consist of mackerel and sprat.

Table C. 3
Percentage composition by species of landings from the young herring fisheries

Country	Total landings	Herring	Other Art. 6	Cod	Haddock	Whiting	Plaice	Dab	Other non-6	All non-6
Denmark	100	85	3	0·1	1	9	+	0·2	0·7	11
Germany	100	83	4	0·3	3	9	+	0·4	1·0	13

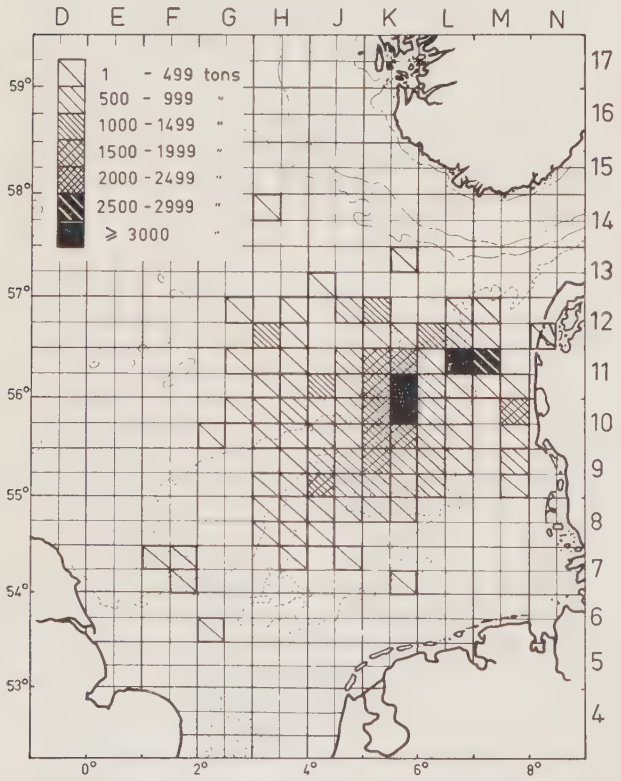


Figure 7. Denmark; landings of young (industrial) herring from the North Sea in 1957.

remaining non-Article 6 species (cod, haddock, plaice, dab, and others) have been made by sub-dividing the total "remaining non-Article 6 species" according to the proportions of these five groups in the German landings. Quantities estimated in this way in Table C. 2 are indicated with an asterisk.

(c) Expressed as percentages of the total landings, these quantities become as set out in Table C. 3.

It should be noted that in this table the categories "other Art. 6", "whiting", and "all non-Art. 6" percentages are obtained from independent statistics for the two fisheries. The close similarity between these figures for the two countries indicates that the two fisheries are themselves very similar in their characteristics, as would be expected from the similarity of their distribution.

C. 5. Proportion of undersized fish in the haddock and whiting by-catches

(a) From the German and Danish contributions, the following percentages by weight of undersized haddock and whiting in the total landings from 1955 to 1957 can be obtained, and are as follows:—

Table C. 4
Undersized haddock and whiting as percentage by weight of the total landings 1955–57

Country	Haddock	Whiting
Denmark.....	No data	about 1
Germany.....	1·0	1·3

(b) From this table and Table C. 3, the quantities (tons) of undersized haddock and whiting can be estimated:—

Table C. 5
Quantities (tons) of undersized haddock and whiting landed annually from young herring fisheries (av. 1955–57)

Country	Haddock	Whiting
Denmark	No data	900
Germany	350	450

(c) In view of the close similarity between the two fisheries, it is reasonable to estimate the quantity of undersized haddock in the Danish landings according to the proportion in the German landings. This gives the estimate:—

$$1{,}300 \times \frac{350}{900} = 500 \text{ tons}$$

and a total for both countries of

$$500 + 350 = 850 \text{ tons}$$

of undersized haddock.

C. 6. Assessment of effect of haddock by-catch from young herring fisheries

(a) The data available on the size composition of the haddock by-catch are insufficient to justify making detailed assessments of the kind set out for the adult herring fisheries. The indications are, however, that if anything the proportion of the smallest fish (i.e., below 20 cm) is lower than in the adult herring by-catch (Tiews, 1957; Kühl, 1958). This is what would be expected, in so far as the area of the young herring fisheries is near the south-eastern edge of the haddock area, where the average size of the fish tends to be higher than in the north.

(b) In Table B. 22 the total weight of undersized by-catch haddock from the adult herring/mackerel fisheries was estimated as 6,600 tons, and in para. B. 33(h) it was concluded that this quantity represented something in the region of 6 % to 10 % of the number of fish at present entering the Convention fisheries at a length of 24 cm. Thus the undersized haddock from the young herring fisheries can be regarded as representing about

$$\frac{850}{6{,}600} \times 10\,\% = 1{\cdot}3\,\%$$

of the fish entering the Convention haddock fisheries.

(c) As in para. B. 33(i), this percentage can be converted to weight; thus it represents

$$1{\cdot}3\,\% \times 84{,}000 = 1{,}100 \text{ tons per year}$$

of marketable haddock. In the case of the young herring fisheries, however, the undersized by-catch is unavoidably landed for reduction, and therefore the true wastage is

$$1{,}100 - 850 = 250 \text{ tons per year}$$

which represents about 0·3 % of the total landings of marketable haddock from the Convention fisheries.

C. 7. Assessment of effect of whiting by-catch from young herring fisheries; General

Unlike haddock, the by-catch of undersized whiting in the young herring fisheries is rather greater than that in the adult herring fisheries (1,350 tons compared with 655 tons). Moreover, size-composition data are available for the Danish and German by-catch whiting, so that it is necessary and possible to make assessments of the same kind as for the adult herring fisheries.

As before, it will be necessary to estimate the number and average size of whiting of two categories,

(a) fish below 20 cm
(b) fish between 20 cm and 27 cm

which correspond exactly to those defined in para. B. 22. It will first be necessary to present the data on the length composition of by-catch whiting in both the Danish and German young herring fisheries.

C. 8. Length composition of by-catch whiting

(a) The length composition of the Danish whiting by-catch is given in the Danish contribution. That of the German by-catch has been published by Kühl (1958). In both cases, the data refer to the years 1955, 1956, and 1957.

(b) Figure 8 shows the percentage length compositions for each country in each of these three years. These data refer to the summer-autumn fishery only, but over 80 % of the catch is taken during this season; moreover, the average length of by-catch whiting in the Danish spring fishery in the Silver Pit area is very similar.

(c) It will be seen from Figure 8 that the main characteristics of the length compositions in all three years are quite closely paralleled in both the Danish and German fisheries. Estimating the average length of whiting comprising categories (a) and (b) gives the results set out in Table C. 6.

It will be seen that although there are large differences in the numbers of fish comprising each category in the three years, the average lengths are very similar both between years and between countries.

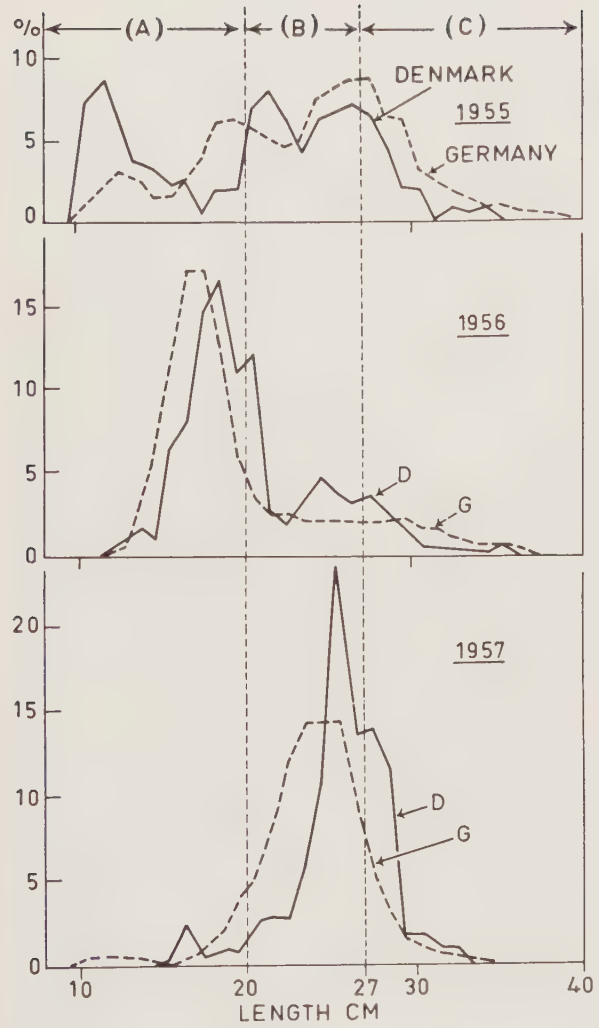


Figure 8. Length composition of by-catch whiting taken in the German (G) and Danish (D) young herring (industrial) fisheries of the North Sea.

Table C. 6
Average lengths of category (a) and (b) by-catch whiting from young herring fisheries

Year	Country	Average length of cat. (a) whiting (< 20 cm)	Average length of cat. (b) whiting (20–24 cm)
1955	Denmark	16	24
	Germany	17	23·5
1956	Denmark	18	23
	Germany	17	23·5
1957	Denmark	18	25
	Germany	18·5	24
Average 1955–57	Denmark	18	24
	Germany	18	24

C. 9. Estimation of number of by-catch whiting of categories (a) and (b)

(a) From Table C. 5 the average quantities of category (a) whiting caught annually by Denmark and Germany are 900 tons and 450 tons respectively. In both fisheries these have an average length of 18 cm (see Table C. 6) which, using the same length/weight conversion as in para. B. 23(b), corresponds to an average weigth of 53 g. Thus the total number of by-catch whiting caught annually in the Danish fishery can be estimated as

$$\frac{900}{53} \times 10^6 = 17 \text{ million fish.}$$

In the German fishery, the total number caught can be estimated as

$$\frac{450}{53} \times 10^6 = 8{\cdot}5 \text{ million fish.}$$

Thus the total annual catch of *category (a)* whiting is

17 million + 8·5 million = 26 million fish.

(b) From Figure 8, the average number of fish in category (a) and category (b) for the three years are in the ratio 1 : 1·36 in the Danish catch; in the German catch the ratio is 1 : 1·23. These ratios are similar, and an average ratio of 1 : 1·3 can be taken for the total number of category (a) fish to category (b) fish. Thus, the total number of *category (b)* fish caught by both countries can be estimated as

26 million × 1·3 = 34 million fish annually.

C. 10. Assessments for category (a) whiting

(a) In para. B. 23 (g) it is estimated that the capture of 20 million of category (a) whiting having an average length of 15 cm represents between 3 % and 4 % of the recruitment to the Convention fisheries. The indications are that the growth-rate of whiting in the area of the young herring fisheries may be a little slower than in the adult herring fisheries of the northern North Sea. On the other hand, the estimated average length of category (a) whiting in the young herring by-catch is a little higher (17 cm compared with 15 cm). These two differences will tend to compensate each other, and if the same figures are used for natural mortality of whiting in the areas, then so far as can be judged, the relative effect of the capture of category (a) whiting will be the same in the two cases.

(b) It therefore follows that the capture of 26 million whiting of category (a) in the young herring

fisheries represents approximately the fraction

$$\frac{26}{20} \times 4\% = 5\%$$

of the fish entering the Convention whiting fisheries at 27 cm.

C. 11. Assessments for category (b) whiting

(a) The assessments given in para. B. 24 for category (b) whiting in the adult herring fisheries were based, *inter alia*, on the assumption that they had an average length of 25 cm. In the present case, the average of category (b) whiting is estimated as 24 cm. Taking the natural mortality of whiting to be the same in the two areas means that instead of 90 % surviving to 27 cm the figure would be about 85 %. Thus of the total of 34 million category (b) fish in the young herring fisheries, about

$$34 \text{ million} \times 85\% = 29 \text{ million fish}$$

would have survived to reach a length of 27 cm if they had not been caught.

(b) Remembering that the total number of whiting entering the Convention fisheries each year at 27 cm has been estimated as 420 million (para. B. 23 (f)), the above catch of category (b) whiting in the young herring fisheries represents the fraction

$$\frac{29}{420} = 7\%$$

of the recruitment to the Convention fisheries of the North Sea.

C. 12. Assessments for total by-catch whiting below 27 cm (categories (a) + (b))

(a) By adding together the percentages arrived at above, the total whiting by-catch of the young herring fisheries which results from the use of meshes smaller than the Convention size represents the fraction

$$5\% + 7\% = 12\%$$

of the fish which enter the Convention fisheries. In terms of the yield from these fisheries, this corresponds to a quantity per year of

$$12\% \times 71{,}000 = 8{,}500 \text{ tons}$$

(b) As explained in para. C. 6(c) to estimate the actual wastage it is necessary to subtract the total quantity of whiting below 27 cm landed for reduction. For category (a) fish, this quantity is 1,350 tons; for category (b) fish, with an average weight of 125 g (corresponding to a length of 24 cm), the quantity can be estimated as

$$34 \times 125 \times 10^6 = 4{,}300 \text{ tons.}$$

Thus the total quantity of whiting below 27 cm landed for reduction is

$$1{,}350 + 4{,}300 = 5{,}700 \text{ tons approximately.}$$

The "biological wastage" of whiting in the industrial fishery is therefore estimated as

$$8{,}500 - 5{,}700 = 2{,}800 \text{ tons}$$

or about 4 % by weight of the whiting landed from the Convention fisheries.

(c) Because the whiting landed with young herring for reduction sells at a considerably lower price (per kilo) than that from the Convention fisheries, it is appropriate to consider briefly what the above estimates of wastage by weight mean in terms of wastage by value. Whiting landed for human consumption have a price of roughly 1 sh/kg (see Bull Stat.), whereas the industrial catch (including whiting) has a price of about 0·3 sh/kg (see Table C. 1). Thus the 5,700 tons of by-catch whiting below 27 cm, caught in the young herring fisheries is equivalent to only

$$5{,}700 \times 0{\cdot}3 = 1{,}700 \text{ tons}$$

of whiting for human consumption in terms of value. Thus the wastage by value is the fraction

$$\frac{8{,}500 - 1{,}700}{71{,}000} = 9{\cdot}6\%$$

of the value of the Convention whiting fisheries.

(d) Similar considerations apply to the haddock by-catch, but this is so small that the wastage even in terms of value is unlikely to exceed 1 %.

C. 13. Some remarks in connection with assessments for the young herring fisheries (North Sea)

(a) As in the case of the assessments for the adult herring fisheries, the question of whether the above estimates are to be regarded as true reductions of the Convention fisheries or of wastage depends on whether all the by-catch whiting surviving to 27 cm would, in fact, migrate into these fisheries. To the extent that they would not have done so, the true effects will be correspondingly less, and so the above estimates are to be regarded in this respect as maximum values. In the present state of knowledge on the migrations and identities of whiting stocks, it is not possible to estimate how wastage due to the young

herring fisheries will be distributed over the Convention whiting fisheries of the various countries.

(b) It is assumed in the above assessments that all the by-catch in the North Sea young herring fisheries is landed. In fact, the amount discarded is negligible.

(c) The quantity of undersized by-catch taken in a particular year in the young herring fisheries is much affected by year-class strength, as can be seen from Figure 8.

(d) It was mentioned in para. B. 14 that in the adult herring fisheries of some countries in some months it is necessary for economic reasons to land the by-catch of haddock and whiting, even though herring is the prime objective. In the young herring fisheries on the other hand, the whitefish by-catch is to a greater or lesser extent unavoidable as the fishing is at present conducted—as is indeed the case in the main part of the adult herring fishery also.

(e) Most of the vessels engaged in the young herring fishery also fish with seine and trawl for Annex II species, especially plaice, at other times of the year. Regulation of the by-catch, if it had the effect of reducing the amount of fishing for young herring, would therefore result in more intensive fishing for plaice and other protected species. In a full appraisal of the young herring fisheries question, these implications, and also the direct effect on the total yield of adult herring, might also need to be taken into account.

C. 14. Statistics of by-catch in the young herring fisheries of the Skagerak/Kattegat

Only Denmark has an important young herring fishery in this area to date (see Table C. 1). Quantities of herring and other species landed for reduction in the three years 1955—57 are given in the Danish contribution; the average species composition of the landings over the three years is given in Table C. 7.

C. 15. Length composition of whiting by-catch

(a) Length samples of the whiting by-catch in the Danish landings are given in the Danish contribution. Figure 9 shows the average length composition for the years 1955—57 for the Skagerak and Kattegat combined, the data for the two areas being weighted according to the landings. It will be noted that compared with the length composition of the by-catch

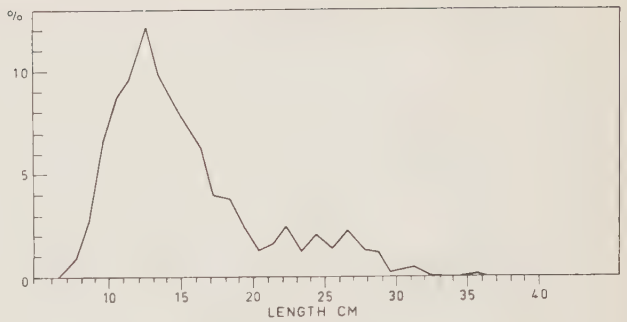


Figure 9. Length composition of by-catch whiting taken in the Danish young herring (industrial fisheries) of the Skagerak/Kattegat, average of years 1955—57.

whiting from the young herring fisheries of the North Sea, the by-catch from the Skagerak/Kattegat contains relatively more small fish.

(b) From Figure 9 it can be calculated that about half the average annual by-catch by weight (i.e., about 5,000 tons) and about 86 % by numbers, consists of undersized whiting (category (a)) about 20 g, so that their numbers are in the region of

$$\frac{5000}{20} = 250 \text{ million fish.}$$

(c) From Figure 9, the numbers of whiting of category (b) (between 20 and 27 cm) are about 12 % of those of category (a), i.e., about 30 million fish.

C. 16. Assessments for whiting by-catch in the young herring fisheries of the Skagerak/Kattegat

(a) Although the weight and number of whiting of the two categories in the by-catch from these fisheries can be estimated approximately in this way, it is scarcely possible at the present time to make any firm assessments of the kind attempted hitherto. The category (a) whiting of these fisheries are much more numerous and of a smaller size (about 13 cm) than in the other mixed fisheries; this means that the question of what natural mortality rate to take for these very small fish in order to calculate their survival to the size at which they would be retained by Convention meshes becomes highly critical. Thus, in the previous instances, the numbers and average sizes of category (a) whiting are such that even assuming perfect survival would still make them only a relatively small percentage of the recruitment to the Convention

Table C. 7
Quantities (tons) and percentages of herring and by-catch landed by Denmark from the Skagerak and Kattegat (av. 1955–57)

	Herring	Mackerel	Sprat	Whiting	Sand-eel	Others	Total
Tons	68,000	3,200	22,000	9,800	4,000	17,000	124,000
% of total	54·9	2·6	17·7	7·9	3·2	13·7	100

fisheries of the North Sea; but when the fish are so small and numerous as in the fisheries of the Skagerak/Kattegat, it is not sufficient to derive maximum possible estimates of this kind.

(b) It is well established that small whiting are preyed upon by larger fish of several species, and this fact makes it probable that their natural mortality rate is substantially higher than that of older fish. The results of Danish research fishing during the period 1927—39 when there was little or no commercial fishing on small whiting in the Skagerak/Kattegat showed that the abundance of year-classes in the catches diminished very rapidly between their first and third years of life, at a rate in the region of 80 % per year. If this is the true natural mortality rate of young whiting in this area then it means that the total by-catch of both categories (a) and (b) whiting taken in the young herring fisheries of the Skagerak/Kattegat would be reduced to some 30 or 40 million fish reaching 27 cm if they had not been caught, equivalent to about 7 % to 10 % of the annual recruitment to the Convention whiting fisheries of the North Sea. It is possible, however, that migration of whiting to other parts of the Skagerak/Kattegat may have influenced the abundance in the research catches, and it is necessary to await confirmation from the results of the more extensive Danish research on whiting in this area, which is at present in progress, before any more definite conclusions can be drawn. It may be noted, however, that for the weight of the by-catch of these small whiting to exactly equal the yield that would be expected from them, if allowed to survive to enter the Convention fisheries, that is, for there to be no nett wastage, would require a very high natural mortality rate in the region of 95 % or more per year.

(c) The other special feature of the whiting stocks of the Skagerak/Kattegat is that their degree of mixing with the North Sea stocks may be quite limited. This conclusion derives from the first results of the Danish tagging experiments started in 1956 which were reported in the Danish contribution; if it is confirmed by subsequent results it would mean that the whiting by-catch taken in the young herring fisheries of the Skagerak/Kattegat would have relatively little effect on the Convention fisheries generally of the North Sea; but, correspondingly, its effect on local Convention fisheries may be considerable. This question of the interrelations between the withing in the area of the young herring fisheries of the Skagerak/Kattegat and the stocks in the North Sea, as well as that of the magnitude of their natural mortality rate, should be resolved when the full results of the Danish research are available.

D. Sand-Eel Fisheries

D. 1.

Statistics of the sand-eel fishery for the year 1957 have been given in Tables A. 1 and A. 2. This fishery was started by Denmark in 1953 and later by other countries. To show the growth of the fishery, data of landings since 1955, when accurate information became available, are given in Table D. 1.

D. 2. Distribution of sand-eel fisheries

These fisheries start in the Horns Reef area at the beginning of the season (April-May) and extend southwards along the Danish and German coasts; by about June-July an important fishery takes place off the Dutch coast. Fishing also occurs on the south-western edge of the Dogger Bank. A small amount of sand-eel (about 4 %) is taken in the Skagerak and Kattegat.

D. 3. Statistics of by-catch

Information on by-catch is available from Denmark (contr.), Germany (contr. and Kühl, 1957) and the Netherlands (contr.). This is summarized in Table D. 2. Danish figures (market samples) are average of data for 1956 and 1957; other countries for 1957 only.

D. 4. Size composition of whiting by-catch

No detailed length-composition data are available, but according to the Danish contribution, 30 % of the whiting by-catch in the Danish fisheries is undersized. The Netherlands contribution gives the estimate that less than 5 % of the whiting by-catch in the Netherlands fishery is undersized. Thus it would seem that something in the region of 150 to 200 tons of undersized whiting is landed from the sand-eel fisheries. This is to be compared with 1,350 tons of undersized whiting landed from the North Sea young herring fisheries (see Table C. 5), and the estimated total of 7,000 tons of undersized whiting caught in both the adult and young herring fisheries of the North Sea and Skagerak/Kattegat. Thus the by-catch of undersized whiting landed from the sand-eel fish-

Table D. 1
Quantities (tons) landed from sand-eel fisheries (North Sea and Skagerak)

Country	Fishery started	Total landings (tons)			Value '000 sh. (1957 only)
		1955	1956	1957	
Denmark	1953	42,000	88,000	76,000	16,000
Germany	1955	?	5,300	25,500	4,800
Netherlands	1957	–	–	3,700	700
Norway	1956	–	1,400	3,200	600
Total		42,000?	94,700	108,400	22,100

Table D. 2
Quantities (tons) of sand-eel and by-catch in the North Sea sand-eel fisheries

Country	Total landings	Sand-eel	Whiting	Dab	Other species
Denmark	79,000	77,700	470	80	780
Germany	25,500	25,300	← 70 →		130
Netherlands	3,700	3,250	← 80 →		370
Total	108,200	106,250	← 700 →		1,300

Notes:
(i) The by-catch statistics of each country have been obtained by sampling either the landings or the catches.
(ii) German figures for by-catch of whiting + dab have been obtained by dividing the total German by-catch according to the proportion of whiting + dab in the Danish and Dutch by-catch.
(iii) It is known that both the German and Dutch by-catch contains more whiting than dab. As a rough estimate, the total whiting by-catch can be taken as about 600 tons.
(iv) Danish research vessel catches just outside a major sand-eel fishery confirmed the low percentage by-catch evident from the above table. (Data of Bertelsen and Popp Madsen, 1958.)

eries would appear to be only some 2 % to 3 % by weight of the catch of undersized whiting by all herring trawl fisheries.

In the absence of length-composition and other data, it is not possible to give any detailed assessments, but the above figures can give some idea of the importance of the by-catch from the sand-eel fisheries.

E. Sprat Fisheries (Trawl)

E. 1. Statistics of sprat fisheries

These have been summarized in Tables A. 1 and A. 2. Catches by Poland and France are small and incidental in the adult herring catch; catches by Denmark are mainly those in the by-catch from the young herring fisheries of the Skagerak and have already been covered under by-catch of those fisheries. There is a small special fishery for sprat by Denmark in the Skagerak, but no detailed statistics are available. More detailed statistics of the sprat fisheries of the remaining countries are given in Table E. 1.

Table E. 1
Quantities (tons) and values landed from sprat fisheries (trawl) of the North Sea and Skagerak (average yearly figures)

Country	Sprat (tons)	Price sh./kg	Sprat, value, '000 sh.	Origin of data
Germany	3,700	0·66	2,400	Contr. '54–'57
Sweden	8,400	1.0	8,400	Contr. + Bull. Stat. '54–'56
Netherlands	1,300	0·66	880	Contr. '54–'57
Belgium	1,300	0·68	885	Contr. '54–'56
Total	14,700	—	12,565	—

Note: Bottom and pelagic trawls are used for sprat fishing, and catches from both are included in the above table.

E. 2. Distribution of sprat fisheries

For the most part, the sprat fisheries are restricted to the coastal areas of the countries concerned.

E. 3. Statistics of by-catch in sprat fisheries

(a) Some information on the composition of the by-catch from the sprat fisheries is given in the contributions from all the four countries listed in Table E. 1, and can be summarized as follows:—

(b) *Germany:* By-catch comprises about 1 % by weight of total landings. Species composition of by-catch not recorded.

(c) *Sweden*: Sprat and herring account for over 85 % of the total landings in the province of Gothenburg and Bohus (which account for over half of the

total landings). Cod comprised 9 % (514 tons) of the total landings in 1954, but no other protected species more than 1 %.

(d) *Netherlands*: As a rough figure, about 5 % by weight of the total landings consists of undersized protected species, mainly dab and a small proportion of whiting. The proportion of marketable sizes of protected species is negligible.

(e) *Belgium:* About 0·2 % of the total landings consists of protected species, mainly dab.

E. 4. Conclusions for sprat fisheries

(a) The proportion of landed by-catch appears to be rather variable, and probably depends on whether the sprat is to be used partly for industrial purposes (as in the Netherlands) or for human consumption. In the latter case the landed by-catch may differ considerably from the by-catch as caught, but no information on the discarded catch is available.

(b) From the above figures, it would seem that the total landed by-catch of protected species from the sprat (trawl) fisheries of the North Sea is in the region of 100 tons, of which a substantial part is probably dab. Thus it can be concluded that the by-catch from the sprat fisheries of the North Sea does not have an important influence on the Convention fisheries, but the same may not be true as far as the cod by-catch in the Skagerak is concerned.

F. Shrimp Fisheries

F. 1. Statistics of shrimp fisheries

A more detailed presentation of the statistics of the shrimp fisheries than those of Tables A. 1 and A. 2 is given in the following table. It should be noted that these data do not include *Pandalus*, and refer only to the North Sea.

Table F. 1
Quantities (tons) and value of annual landings from shrimp fisheries

Country	Landings (tons)	Price sh./kg	Value ('000 sh.)	Origin of data
Germany....	35,900	0·34	12,000	Contr. '54–'57
France.....	240	5·2	1,300	Bull. Stat. '54–'56
Netherlands .	15,700	0·85	13,400	Contr. '54–'57
Belgium.....	2,300	3·3	7,500	Contr. '54–'56
England	1,600	1·8	2,800	Bull. Stat. '54–'56
Total.....	55,740		37,000	

Note: Figures for France include crabs (*Portunus*).

F. 2. Distribution of shrimp fisheries

All the fisheries are coastal, and much of the catch is taken from very close to the shore.

F. 3. Statistics of by-catch

(a) By-catch information is provided in the contributions from Germany and the Netherlands, and gives a similar picture. A summary is a follows: —

(b) The by-catch from the shrimp fisheries of both countries is very variable, both in area and season. It seems from the Netherlands data that the by-catch of marketable species is about 10 % by weight of the total catch, and consists mainly of plaice and dab.

(c) From the landings of small shrimp for industrial purposes, an estimate can be made of the proportion of undersized protected species in the catch. Both the German and Netherlands data indicate that about 5 % of the total landings for industrial purposes consists of undersized protected species. Data for Germany are as follows:—

Table F. 2
Undersized protected species as percentage of total quantities of shrimp landed for industrial purposes in Germany

Species	Plaice	Dab	Sole	Whiting	Cod
Percentage of undersized fish.....	2·7	0·8	1·1	0·4	0·2

No detailed information is available for the Netherlands industrial by-catch, but it is reasonable to suppose that its composition is similar.

(d) In both countries, the landings of shrimp for industrial purposes comprise by far the greater part of the total landings and the above figures are probably representative. Thus an estimate can be made of the average quantity of undersized protected species in the by-catch from the shrimp fisheries of both Germany and the Netherlands together (which accounts for about 95 % of the total) and is as follows:—

Table F. 3
Estimated quantities (tons) of undersized protected species landed in by-catch of shrimp fisheries of Germany and Netherlands

Total landings from shrimp fisheries (tons)	Undersized protected species (tons)				
	Plaice	Dab	Sole	Whiting	Cod
51,600	1,390	410	570	210	100

(e) In the absence of length-composition data for the undersized protected species, no detailed assess-

ments can be made, but some comparisons are as follows:—

Plaice. Undersized by-catch is about 2 % of total North Sea landings of marketable plaice.

Sole. Undersized by-catch is about 3 % of total North Sea landings of marketable sole.

Whiting. Undersized by-catch is about 10 % of the total undersized by-catch whiting caught in the adult and young herring fisheries of the North Sea.

(f) It may be concluded that whereas the by-catch of whiting and cod does not seem large enough to have any substantial effects, the figures for plaice and sole are by no means insignificant, because many of these fish are in their first year of life and thus very small. A further appraisal of the implications to the fisheries for these two species may be thought necessary, but more detailed information on the by-catch would be needed.

G. *Nephrops* Fisheries

H. *Pandalus* Fisheries

G. 1.

General statistics for the North Sea *Nephrops* fisheries have been given in Tables A. 1 and A. 2. *Nephrops* is widespread in the North Sea and adjacent waters and is caught both in special fisheries and as a by-catch. No information is available on the magnitude or composition of the by-catch in the special fisheries, but in view of the relatively small quantities of *Nephrops* landed, these fisheries would not seem to constitute a serious problem.

H. 1.

Pandalus borealis has not been included in the general tables, but a summary of the landings are as shown in Table H. 1 (av. 1954—56, Bull. Stat.).

H. 2.

Pandalus is restricted for the most part to the deep water of the Norwegian Deeps and the Skagerak/Kattegat.

Table H. 1
Annual landings of Pandalus from the North Sea and Skagerak/Kattegat

Country	Area	*Pandalus* (tons)
Sweden	Skagerak and Kattegat	1,500
Norway	North Sea	2,700
	Skagerak	730
Denmark	Skagerak	720
Total		5,650

H. 3.

By-catch information from the Swedish *Pandalus* fisheries in the Skagerak is available from the Swedish contribution for the province of Gothenburg and Bohus. The main recorded by-catch is cod and witch; these each constitute in the region of 2 %—3 % of the total landings. A substantial proportion of the total landings (about ¼) may be recorded as industrial fish, and this may include undersized protected species. The magnitude of the *Pandalus* fisheries is, however, small compared with those of most other Article 6 fisheries.

J. Summary of Conclusions Concerning By-catch in Mixed Fisheries

J. 1. Adult herring/mackerel fisheries

(a) The main protected (Annex II) species comprising the by-catch in these fisheries are cod, haddock, and whiting, but detailed information is available only for whiting and haddock.

(b) The annual by-catch of *whiting* taken by all countries (except Sweden) by small-meshed gears in the adult herring/mackerel fisheries of the North Sea over the years 1954—57 averaged about 24,000 tons (Table B. 16); for the *haddock* by-catch the corresponding figure was 30,000 tons (Table B. 22).

(c) It is estimated that an average of about 650 tons of the annual *whiting* by-catch were of fish below the Convention size limit of 20 cm (Table B. 16), and that a further 7,000 tons were of fish between 20 cm and 27 cm, that is, they were of legal size but too small to be retained, on average, by Convention meshes. If these fish, instead of being caught by small-meshed gears, were to have grown to the average size at which whiting enter the Convention fisheries (27 cm), the survivors from the undersized by-catch would have represented about 4 % of the total number of fish recruited annually to the Convention fisheries, and the remainder (i.e., the fish between 20 cm and 27 cm) about 13 %. Thus the total survival would have represented about 17 % of the recruitment to the Convention fisheries, equivalent to a catch as adult fish of about 12,000 tons per year.

(d) It is estimated that over the same period of years the annual by-catch of *haddock* taken by all countries (except Sweden) which consisted of fish below the Convention size limit of 27 cm averaged about 6,600 tons (Table B. 22). However, because this size limit is above the 50 % retention length of Convention meshes in the case of haddock (24 cm), only that fraction of the undersized haddock by-catch consisting of fish smaller than 24 cm were caught specifically because small-meshed gears were used. It is estimated that these fish amounted to about 4,700 tons; and if, instead of being caught in this way, they had grown to the average size at which haddock enter the Convention fisheries (24 cm), it is estimated that the survivors to this length would have represented about 10 % of the total number of fish recruited annually to the Convention haddock fisheries of the North Sea, equivalent to an annual catch of about 8,000 tons.

(e) All the by-catch of undersized *whiting* are discarded at sea and therefore wasted, but it is estimated that about 3,000 tons of the 7,000 tons of legal sized whiting between 20 cm and 27 cm were landed. Thus the "nett wastage" of whiting resulting from the use of small-meshed gears as opposed to gears with Convention meshes is about 12,000 — 3,000 = 9,000 tons per year, or about 13 % of the Convention landings from the North Sea during the year in question.

(f) Since all the by-catch of *haddock* less than 24 cm in length are undersized fish and are discarded, the "nett wastage" is the same as the catch that would have been obtained from these fish had they been allowed to grow and enter the Convention fisheries, i.e., 8,000 tons per year.

J. 2. Young herring (industrial) fisheries in the North Sea

(a) The by-catch in these fisheries consists primarily of whiting, with haddock the next in importance (Table C. 2).

(b) The average annual by-catch of *whiting* taken in the young herring fisheries of the North Sea by all countries over the years 1955—57 was about 11,300 tons; the *haddock* by-catch was about 2,200 tons.

(c) It is estimated that about 1,350 tons of the annual *whiting* by-catch were of undersized fish, and a further 4,300 tons were estimated to be between 20 cm and 27 cm in length and so would not have been caught by Convention meshes. Had these fish not been caught, the survivors from the undersized by-catch reaching the size of entry to the Convention fisheries would have represented about 5 % of the recruitment to these fisheries, and the remainder about 7 %. Thus the total survival would have represented about 12 % of the recruitment to the Convention fisheries, equivalent to an annual catch as adult fish of some 8,500 tons per year.

(d) The by-catch of undersized *haddock* in these fisheries is estimated to have been in the region of 850 tons annually for the years in question, representing about 1·3 % of the recruitment to the Convention fisheries and equivalent to an annual catch of about 1,100 tons as adult fish.

(e) The "nett wastage" of *whiting* which results from the use of small-meshed gear in the young herring fisheries of the North Sea is in the region of 3,000 tons per year or about 4 % of the Convention landings; for *haddock*, the "nett wastage" is about 250 tons, which is less than 1 % of the Convention landings.

J. 3. Young herring (industrial) fisheries in the Skagerak and Kattegat

(a) As in the North Sea fisheries of this kind, the main species comprising the by-catch taken in the young herring fisheries of the Skagerak and Kattegat is *whiting*, of which the average quantity caught over the years 1955—57 is estimated as about 9,800 tons per year (Table C. 7).

(b) This quantity of by-catch whiting is similar to that taken in the young herring fisheries of the North Sea but the fish are of a smaller average size. It is estimated that in the year in question an average of about 5,000 tons per year of undersized whiting were caught, with a further 2,500 tons of fish between 20 cm and 27 cm.

(c) No definite estimate can at present be made of what fraction of these fish would have survived to the size of retention by Convention meshes had they not been caught by small-meshed trawls. There are indications, however, that the natural mortality rate of young whiting in the Skagerak/Kattegat may be very high and, consequently, that the fraction of the by-catch which would have survived may be less than has been estimated for the North Sea fisheries.

(d) Preliminary results of Danish research suggest that there may not be much mixing between whiting of the Skagerak/Kattegat and those of the North Sea proper; if this is confirmed, it means that the by-catch whiting taken in the young herring fisheries of the Skagerak/Kattegat may not have any appreciable effect on the Convention whiting fisheries of the North Sea.

J. 4. Sand-eel fisheries

In general, the by-catch appears to form only a very small proportion of the total catch in these fisheries as they have so far been conducted (Table D. 2). The main species in the by-catch is *withing*, and the total annual catch of undersized whiting is in the region of 3 % of the by-catch of undersized by-catch whiting taken in all the herring trawl fisheries.

J. 5. Sprat fisheries (trawl)

These fisheries are restricted to coastal regions of the North Sea and the Skagerak/Kattegat. In recent years, the total annual by-catch taken in the North Sea fisheries is estimated to be in the region of 100 tons, of which a large part is probably *dab*, so there appears to be no reason for concern as regards the effect on the Convention fisheries of the North Sea. In the Skagerak/Kattegat, on the other hand, the *cod* by-catch is more substantial, and the effect on the cod fisheries of that area may not be negligible.

J. 6. Shrimp fisheries

All these fisheries are coastal and are conducted mainly near the shore. The landings are used mostly for industrial purposes. In the years 1955—57 it is estimated that about 2,700 tons, or 5 % of the total catch, consisted of undersized protected species (Table F. 3). The effect of the shrimp fisheries on the Convention fisheries of the North Sea is likely to be small, with the exception of those for *plaice* and *sole*; the total by-catch of these two species comprised some 2 % and 3 % respectively of the North Sea landings in recent years. No detailed information of the size composition of the by-catch of plaice and sole is available, but having regard to the fact that the shrimp fisheries are coastal it is probable that most of the plaice and sole are very small; in which case the effect on the Convention fisheries for these two species may prove to be very significant.

J. 7. Nephrops fisheries

No information is at present available on the by-catch taken in the *Nephrops* fisheries. The magnitude of these fisheries is, however, small in comparison with most other Article 6 fisheries considered in this report and it does not seem that they constitute a serious problem at the present time.

J. 8. Pandalus fisheries

These fisheries are conducted mainly in the deep water off Norway and the Skagerak. The main species recorded in the by-catch are *cod* and *witch* (Table H. 1) but, again, the magnitude of these fisheries is relatively small.

J. 9. General summary and some concluding remarks

(a) On the evidence submitted, the main protected (Annex II) species comprising the by-catch taken by small-meshed trawls in Article 6 fisheries are *whiting* and *haddock*, in that order of importance. It is believed that the data available on the by-catch of these two species are sufficient to enable the order of magnitude of the effect of this by-catch, relative to the North Sea Convention fisheries for these species, to be estimated for the period 1954—57.

(b) The total by-catch of *whiting* which consisted of fish too small to be retained by Convention meshes but which were taken in the small-meshed trawl fisheries for adult and young herring in the North Sea by all countries except Sweden, is estimated to be equivalent to about 29 % of the average number of fish recruited annually to the Convention whiting fisheries of the North Sea during the period 1954—57. Making what is probably a maximum estimate of the

Swedish by-catch of whiting, and including also the whiting by-catch taken in other Article 6 fisheries for which data are available, increases this figure to about 33 %. The comparable figure for the total *haddock* by-catch taken in all Article 6 fisheries is in the region of 12 % of the annual recruitment to the Convention haddock fisheries of the North Sea.

(c) The total "nett wastage" of *whiting* due to the capture of small fish by trawls with meshes smaller than Convention sizes, is estimated to be in the region of 14,000 tons per year, or about 20 % of the landings from the North Sea Convention fisheries in recent years. For *haddock*, the corresponding nett wastage is estimated as about 10 % of the annual Convention landings, or about 8,500 tons per year.

(d) In arriving at the figures on which the above summaries are based, the principle has been followed, where doubt exists, of using data which tend to give the highest reasonable estimates of the by-catch or of its effect relative to the Convention fisheries, although in the text of the report some idea of the possible range of answers is also given where relevant. One instance of the application of this principle concerns the values of natural mortality rate used to calculate the probable survival of the smaller haddock and whiting to the sizes at which they would be retained by Convention meshes. Thus, in the absence of direct numerical estimates, especially for the undersized whiting (category (a)), it has been preferred to take values of natural mortality rate which may be too low rather than too high, in order that the effect of the by-catch shall not be underestimated.

(e) A few words of explanation are also needed concerning the interpretation of the estimates of effect of by-catch on Convention fisheries. If all the whiting and haddock by-catch of fish below the 50 % retention length of Convention meshes could have been avoided, and if all the fish surviving as a result were to enter the Convention fisheries and be subject to the full fishing intensity in them, then it follows that the catch of marketable fish from these fisheries would increase by the percentages estimated. Probably this second assumption is not far from the truth so far as haddock is concerned, but the position for whiting is more complicated. Thus, recent evidence is tending to show that North Sea whiting does not consist of a single homogeneous stock but of several partially independent ones, and it is probable that the effect of fishing with small-meshed trawls is greater in the Convention whiting fisheries in certain parts of the North Sea than in others. A further point is that if the by-catch in only one of the mixed fisheries could be avoided, the gain to the Convention fisheries would be somewhat less than the percentages for that fishery estimated above, because some of the fish saved would probably enter other mixed fisheries and so increase the wastage in them. No account of such interrelations between mixed fisheries can be made from the data available at the present time.

(f) In assessing the effect of mesh regulations in Convention fisheries, it is usually sufficient to estimate the gain or loss for each species independently. In the present case, however, the loss involved in catching a protected species as a by-catch in a mixed fishery is directly connected with the exploitation of an unprotected species which could not be carried out with trawls or seines of Convention mesh sizes. A further complication is that some, at least, of the fishing effort in mixed fisheries would, if those fisheries were restricted, be diverted to the further exploitation with Convention meshes of protected (Annex II) species.

References

Ad Hoc Report, 1957. "International Fisheries Convention, 1946. Report of the *Ad Hoc* Committee". J. Cons. int. Explor. Mer, *23*: 7—37.

Bertelsen, E., & Popp Madsen, K., 1958. "Some observations on sand-eels (*Ammodytes*). Biology and fishery". ICES, Pap. No. 99.

Ellis, R. W., & Jones, R., 1956. "The whiting (*Gadus merlangus* L.) in the North Sea". Mar. Res. Scotl., 2.

Kühl, H., 1958. "Die deutsche Fischerei auf Industriefisch in der Nordsee in Jahre 1957". Arch. Fischereiwiss., *8*: 181—97.

Messtorff, J., 1959. "Untersuchungen über die Biologie des Wittlings (*Merlangus merlangus* L.) in der Nordsee". Dtsch. wiss. Komm. Meeresforsch., *15*: 277—334.

Sahrhage, D., 1958. "Untersuchungen über die Vernichtung untermassiger Schellfische durch die deutsche Heringsschleppnetzfischerei in der Nordsee". Ber. Dtsch. wiss. Komm. Meeresforsch., *15*: 105—31.

Sahrhage, D., 1959. "Untersuchungen über den Anteil untermassiger Wittlinge in den Fängen der deutschen Heringsschleppnetzfischerei in der Nordsee". Ibid., *15*: 335—56.

Tiews, K., 1956. "Untersuchungen über die deutsche 'Ölheringsfischerei' in der Nordsee im Jahre 1955". Arch. Fischereiwiss., *7*: 47—60.

NB. Une **LISTE DES PUBLICATIONS** du Conseil Permanent International pour l'Exploration de la Mer est envoyée **franco**, sur demande adressée à MM. **Andr. Fred. Høst et fils**, libraires à Copenhague.

Série A: Rapports et Procès-Verbaux des Réunions

– B_1: Bulletin Hydrographique
Synoptic Hydrographic Charts

– C_1: Journal du Conseil

– D: Bulletin Statistique
Statistical News Letters

– E_1: Fiches d'Identification du Zooplancton

– F: Annales Biologiques

Les séries suivantes ont cessé de paraître:

Série B: Bulletin (trimestriel) des résultats acquis pendant les croisières périodiques etc.
a. Bulletin Planktonique
b. Résumé des Observations sur le Plankton

– C: Publications de Circonstance

– E: Fiches Faunistiques

IMPRIMERIE BIANCO LUNO A/S
COPENHAGUE